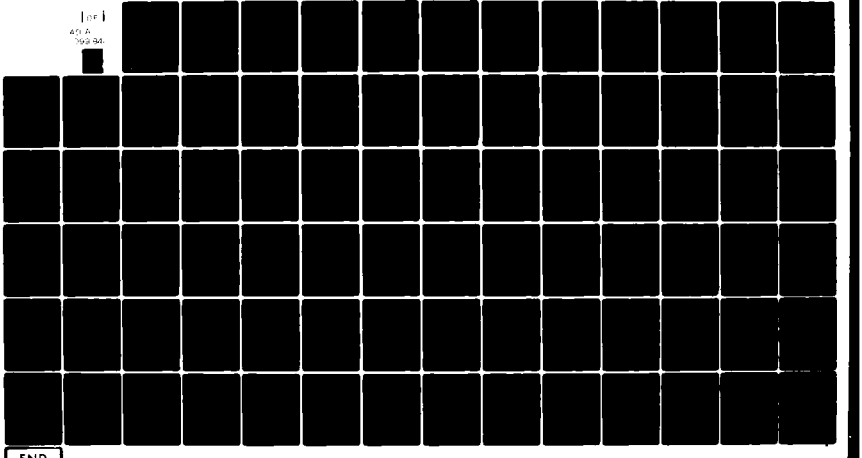
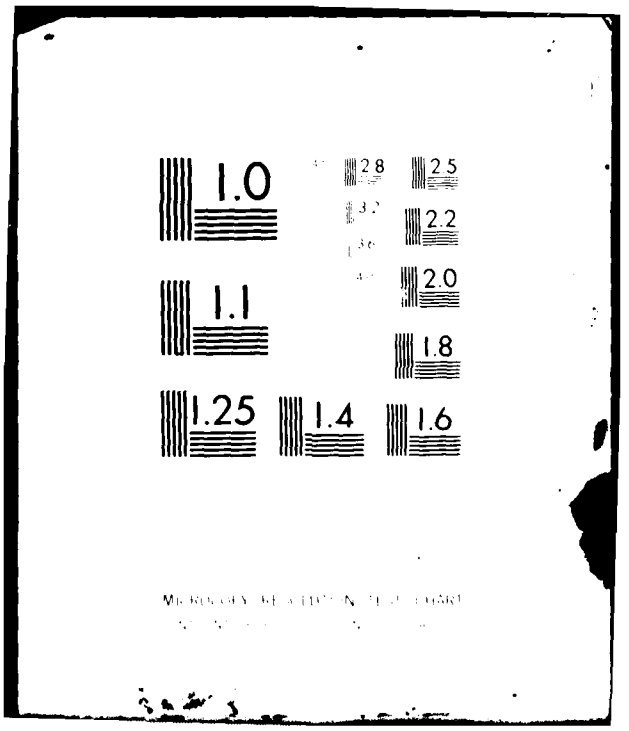
AD-A099 841 COURSEWARE INC SAN DIEGO CALIF F/G 5/9
F-16 TRAINING MEDIA MIX.(U)
MAR 81 A S GIBBONS, A F O'NEAL, D R FARROW F02604-79-C-8875
UNCLASSIFIED NL



END
DATE FILED
6-81
DTIC


1.0
1.1
1.25
1.4
1.6
2.8
2.5
2.2
2.0
1.8

AD A099841

LEVEL II

F-16 AIRCREW TRAINING DEVELOPMENT PROJECT

Contract No. F02604-79-C8875

See also AD-A099 844.

DTIC
ELECTE
JUN 0 3 1981
S D
E

F-16 TRAINING MEDIA MIX.

DEVELOPMENT REPORT No. 31.

MAR 81

Prepared in fulfillment of CDRL no. B043

by

A.S./Gibbons
A.F./O'Neal
D.R./Farrow
R.H./Axtell
J.A./Hughes
Courseware, Inc.

DTIC FILE COPY

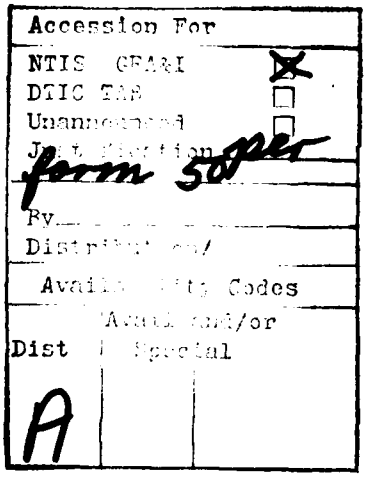
COURSEWARE, INC.
10075 Carroll Canyon Rd.
San Diego, CA 92131
(714) 578-1700

STATEMENT A
Approved for public release;
Distribution Unlimited

81 6 08 199

PREFACE

This report was created for the F-16 Aircrew Training Development Project contract no. F02604-79-C8875 for the Tactical Air Command to comply with the requirements of CDRL no. B043. The project entailed the design and development of an instructional system for the F-16 RTU and instructor pilots. During the course of the project, a series of development reports was issued describing processes and products. A list of those reports follows this page. The user is referred to Report No. 34, A Users Guide to the F-16 Training Development Reports, for an overview and explanation of the series, and Report No. 35, F-16 Final Report, for an overview of the Instructional System Development Project.



F-16 AIRCREW TRAINING DEVELOPMENT PROJECT REPORTS

Copies of these reports may be obtained by writing the Defense Technical Information Center, Cameron Station, Alexandria, Virginia 22314. All reports were reviewed and updated in March 81.

Gibbons, A.S., Rolnick, S.J., Mudrick, D. & Farrow, D.R. Program work plan (F-16 Development Report No. 1). San Diego, Calif.: Courseware, Inc., September 1977, March 1981.

Thompson, A., Bath, W., & Gibbons, A.S., Previous ISD program review (F-16 Development Report No. 2). San Diego, Calif.: Courseware, Inc., September 1977, March 1981.

Wild, M., & Farrow, D.R. Data collection and management forms report (F-16 Development Report No. 3). San Diego, Calif.: Courseware, Inc., September 1977, March 1981.

Gibbons, A.S. Review of existing F-16 task analysis (F-16 Development Report No. 4). San Diego, Calif.: Courseware, Inc., June 1977, March 1981.

Gibbons, A.S., & Rolnick, S.J. Derivation, formatting, and use of criterion-referenced objectives (CROs) and criterion-referenced tests (CRTs) (F-16 Development Report No. 5). San Diego, Calif.: Courseware, Inc., September 1977, March 1981.

Rolnick, S.J., Mudrick, D., Gibbons, A.S. & Clark, J. F-16 task analysis, criterion-referenced objective, and objectives hierarchy report (F-16 Development Report No. 6). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Gibbons, A.S. Task analysis methodology report (F-16 Development Report No. 7). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Gibbons, A.S. Objectives hierarchy analysis methodology report (F-16 Development Report No. 8). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Mudrick, D., Gibbons, A.S., & Schmidt, R.F. Goal analysis report (F-16 Development Report No. 9). San Diego, Calif.: Courseware, Inc., February 1978, March 1981.

Rolnick, S.J., Mudrick, D., & Thompson, E.A. Data base update procedures report (F-16 Development Report No. 10). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Mudrick, D., & Pyrz, K.E. Data automation of task and goal analysis: Existing system review and recommendation (F-16 Development Report No. 11). San Diego, Calif.: Courseware, Inc., September 1977, March 1981.

O'Neal, A.F., & Smith, L.H. Management System needs and design concept analysis (F-16 Development Report No. 12). San Diego, Calif.: Courseware, Inc., December 1977, March 1981.

Gibbons, A.S., Thompson, E.A., Schmidt, R.F., & Rolnick, S.J. F-16 pilot and instructor pilot target population study (F-16 Development Report No. 13). San Diego, Calif.: Courseware, Inc., September 1977, March 1981.

Schmidt, R.F., Gibbons, A.S., Jacobs, R. & Faust, G.W. Recommendations for the F-16 performance measurement system (F-16 Development Report No. 14). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Thompson, E.A., & Gibbons, A.S. Program/system constraints analysis report (F-16 Development Report No. 15). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Gibbons, A.S., & Rolnick, S.J. A study of media production and reproduction options for the F-16 project (F-16 Development Report No. 16). San Diego, Calif.: Courseware, Inc., February 1978, March 1981.

O'Neal, A.F., & Kearsley, G.P. Computer managed instruction for the F-16 training program (F-16 Development Report No. 17). San Diego, Calif.: Courseware, Inc., July 1978, March 1981.

Wilcox, W.C., McNabb, W.J., & Farrow, D.R. F-16 implementation and management plan report (F-16 Development Report No. 18). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Sudweeks, R.R., Rolnick, S.J., & Gibbons, A.S. Quality control plans, procedures, and rationale for the F-16 pilot training system (F-16 Development Report No. 19). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Gibbons, A.S., Axtell, R.H., & Hughes, J.A. F-16 media selection and utilization plan report (F-16 Development Report No. 20). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Thompson, E.A., Kearsley, G.P., Gibbons, A.S., & King, K. F-16 instructional system cost study report (F-16 Development Report No. 21). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Jacobs, R.S., & Gibbons, A.S. Recommendations for F-16 operational flight trainer (OFT) design improvements (F-16 Development Report No. 22). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Gibbons, A.S. F-16 instructional sequencing plan report (F-16 Development Report No. 23). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

Farrow, D.R., & King, K. F-16 coursewares and syllabi delivery schedule (F-16 Development Report No. 24). San Diego, Calif.: Courseware, Inc., September 1979, March 1981.

Rothstein, L.J., Hibian, J.E., & Mudrick, D. F-16 instructor/course manager training requirements report (F-16 Development Report No. 25). San Diego, Calif.: Courseware, Inc., October 1978, March 1981.

O'Neal, A.F., & O'Neal, H.L. F-16 pilot media selection (F-16 Development Report No. 26). San Diego, Calif.: Courseware, Inc., March 1979, March 1981.

Gibbons, A.S. F-16 instructional system design alternatives (F-16 Development Report No. 27). San Diego, Calif.: Courseware, Inc., September 1979, March 1981.

Gibbons, A.S. F-16 instructional system basing concept (F-16 Development Report No. 28). San Diego, Calif.: Courseware, Inc., September 1979, March 1981.

O'Neal, H.L., & Rothstein, L.J. Task listings and criterion-referenced objectives for the instructor pilot F-16 training program (F-16 Development Report No. 29). San Diego, Calif.: Courseware, Inc., September 1979, March 1981.

Bergman, D.W., & Farrow, D.R. F-16 training system media report (F-16 Development Report No. 30). San Diego, Calif.: Courseware, Inc., September 1979, March 1981.

Gibbons, A.S., O'Neal, A.F., Farrow, D.R., Axtell, R.H., & Hughes, J.A. F-16 training media mix (F-16 Development Report No. 31). San Diego, Calif.: Courseware, Inc. October, 1979, March 1981.

Farrow, D.R. F-16 training media support requirements (F-16 Development Report No. 32). San Diego, Calif.: Courseware, Inc., September 1979, March 1981.

Gibbons, A.S. F-16 training media constraints and limitations (F-16 Development Report No. 33). San Diego, Calif.: Courseware, Inc., September 1979, March 1981.

Farrow, D.R., & Kearsley, G.P. A user's guide to the F-16 training development reports (F-16 Development Report No. 34). San Diego, Calif.: Courseware, Inc., January 1981, March 1981.

Farrow, D.R., & Clark, J. F-16 Final Report (F-16 Development Report No. 35). San Diego, Calif.: Courseware, Inc., January 1981, March 1981.

EXECUTIVE SUMMARY

The media selection process utilized in this program is documented in three separate reports. Report No. 20, "F-16 Media Selection and Utilization Plan Report", describes the initial 31 step procedure designed to select instructional media for various categories of objectives. Report No. 31, "F-16 Training Media Mix", describes the 15 step procedure actually employed on the project. Report No. 26, "F-16 Pilot Media Selection", provides the raw data used in the selection process. Taken together, they provide a detailed description of the rationales employed, procedures followed, data generated, recommendations made, and media mix utilized.

Media selection consists of assigning instructional media to groups of objectives in such a way as to maximize training effectiveness while minimizing training costs. All objectives are sorted into one of two major categories: academic objectives and hands-on objectives. Both sets are then processed along parallel channels, whereby the requirements of each objective are computer matched to the capabilties of each medium. This produces a prioritized list of media to match each objective. These objectives are then grouped into lessons, trainer sessions, or sorties according to commonalities of both content and medium. Later, during the syllabus building process, these lessons, sessions, and sorties are sequenced into a functional curriculum.

CONTENTS

		Page
Preface		i
F-16 Aircrew Training Development Project Reports		ii
Executive Summary		v
1.0	INTRODUCTION	1
1.1	Purpose	1
1.2	Organization	2
2.0	RATIONALE	3
2.1	The Scope of Media Selection Activities	3
2.2	Media Selection in Relation to Other Instructional Development Processes	4
2.3	Factors in Media Selection	5
2.4	Constraints Upon Media Selection	9
3.0	MEDIA SELECTION PROCESS	15
3.1	Step 1: Sort Objectives into Academic and Training Device Groups	18
3.2	Step 2: State all Nonstrategy Factors Affecting Media Selection	19
3.3	Step 3: List the Media Pools	22
3.4	Step 4: Evaluate the Instructional Characteristics of All Media	25
3.5	Step 5: Reconfigure Media to Produce Alternate Media Lists	33
3.6	Step 6: Determine Instructional Media Requirements for Each Objective	39
3.7	Step 7: Determine Alternate Media Assignment Patterns	40
3.8	Step 8: Determine Media Production and Maintenance Cost	46
3.9	Step 9: Construct the Media Decision Models	46

CONTENTS (cont.)

Page

3.10 Step 10: Select Media for All Objectives under Each Assignment Pattern 46

3.11 Step 11: Determine the Total Cost of Eacn Media Assignment Pattern 46

3.12 Step 12: Review Cost Tradeoffs Related to Each Assignment Pattern 50

3.13 Step 13: Develop Near Term and Far Term Selections 62

3.14 Step 14: Prepare Segment List 67

3.15 Step 15: Update Media Selection 68

4.0 LIST OF AUDIO VISUAL PROGRAMS 69

References 73

LIST OF FIGURES AND TABLES

Page

FIGURES

1. Media-Related Costs 7
2. Flow Diagram of the Media Selection Model 17
3. Media Selection Model 48

TABLES

1. Academic Objective Analysis Worksheet 20
2. Training Device Objective Analysis Worksheet 21
3. Academic Media Selection Matrix 34
4. Training Device Media Selection Matrix 35
5. Completed Academic Media Selection Form 41
6. Completed Training Device Media Selection Form 42
7. Media Patterns and Segments Selected 43
8. Cost to Develop, Produce, and Revise a Single Medium Module 46
9. Total Program Costs for Each Media Pattern 49
10. Media Pattern Cost Trade-off Rankings 61
11. Far Term Syllabus Academic Media Selection 63
12. Near Term Syllabus Academic Media Selections 63
13. Revised Near Term Syllabus Academic Media Selections 65
14. Near Term Syllabus Training Device Selections 66
15. Far Term Syllabus Training Device Media Selections . . . 67

F-16 TRAINING MEDIA MIX

1.0 INTRODUCTION

Media selection is a process of minimizing costs attendant to media acquisition, use, and maintenance while maximizing instructional effectiveness. It is an engineering process in which the benefits which can be realized through application of learning principles and instructional research are balanced against the lessons of experience and economics in designing real-world instructional systems and providing for the necessary equipment and instructional materials.

Media selection is one stage of the instructional development process which is partly administrative in nature and partly governed by the principles of psychology and learning. On one hand it uses factor optimization decision-making techniques to produce a "best" media decision in the presence of conflicting goals. This resolution of the conflicting demands for instructional sophistication, economy, and ease of administration is very much an administrative concern. On the other hand media selection must take into account the creative application of the principles of instructional strategy and materials development that allow it to happen. Without a judgment along this dimension, two competing media selection plans must be assumed equally effective, regardless of the sophistication of the media devices chosen.

Few processes affect an instructional system's cost and practical utility as profoundly as media selection. The development of an instructional system for aircrew training commonly involves the expenditure of thousands of dollars for learning center media, the expenditure of still other thousands of dollars over the lifetime of the system on the development and update of mediated instruction, and multi-millions of dollars for aircraft simulation training devices. Decisions made during the media selection process have a tremendous financial impact.

1.1 Purpose

The purpose of this paper is to outline the method and rationale for the selection of both learning center and training device media for use in the F-16 instructional system. The F-16

instructional developers have attempted to address two main problems which presently exist in the media selection process: (1) the problem of striking a balance between the instructional and economic factors which influence media decisions in such a way that one kind does not suffer unduly at the hands of the other and (2) the problem of systematizing consideration of these major factors in the context of an organized process. Though the methodology reported here was developed in the context of instructional system development for a single-seat aircraft, it is felt that minor adaptations can render the methodology usable for multi-person crews of any number and non-aircrew training applications as well.

1.2 Organization

The main body of this report is contained in Sections 2.0 and 3.0. Section 2.0 is introductory. It outlines the media selection problem and relates the media selection process to other instructional development processes. In particular, the media selection document is characterized as a "living" document to be maintained on a continual basis along with several other instructional system data base documents. This maintenance procedure insures that the instructional development principles built into the system during its design remain there during its operation. This section also names the set of factors and constraints which need to be balanced during media selection. Section 3.0 describes the media selection process. The F-16 media plan resulting from the media selection process described in Section 4.0.

2.0 RATIONALE

This section relates the media selection process to other development, practical, and economic concerns. It begins with a statement of the scope of media selection activities, describes how media selection influences and is influenced by other instructional development activities, and discusses the balancing factors and constraints which operate within media selection.

2.1 The Scope of Media Selection Activities

Media selection for aircrew training consists of two main categories of activity. The first deals with selection of media for use in learning centers for information and knowledge conveyance and practice. This includes well-known standard media types varying from the very simple and inexpensive (e.g., charts, worksheets, and summary pages) to the complex and costly (e.g., computer-assisted instruction, table-top trainers, and videotape recording). It includes media which are intended for use by isolated students (e.g., workbooks, worksheets, and tutorials), students in small groups (e.g., discussion groups and problem-solving exercises) and students in large groups (e.g., lecture).

A second area of media selection centers in the selection or configuration of simulation training devices which are intended to create to some degree a real-world-like performance environment in which the student may practice either part-task or complete behaviors. Examples in this area also range from the simple (e.g., dead systems, mock-up panels, displays), to the complex (e.g., operational flight trainers, computer avionics simulations, weapon system trainers), depending on the scope of the enviromental factors being simulated.

There is much uncertainty and debate in the training device design area of media selection because of the growing complexity of training devices and simulated environments and the uncertainty surrounding the actual instructional effectiveness of given optional configurations. In the past no systematic body of research data or detailed record has been compiled to guide developers in specifiying training device characteristics, and the practice of determining device characteristics in a non-subjective, organized fashion from a statement of the training requirements has not been widely adopted.

Because there is a degree of indefiniteness involved in both areas of media selection and some difficulty in supplying firm answers to either learning center or training device media selection questions, the process of selection is not generally as precise an activity as instructional designers would desire. Subjective approaches to selection abound, although some highly systematic methods have been created (Braby, et. al., 1975). For the most part, the problem faced by the developer is a matter of distinguishing between necessities and nonnecessities.

2.2 Media Selection in Relation to Other Instructional Development Processes

While earlier stages in the instructional development process are analytic phases which gather and correlate data for use by the developer, media selection is a synthetic, or design, stage in which plans are formulated which give structure to the instructional system. Media selection builds on the products of previous development stages, and takes place interactively with other development tasks, therefore it is appropriate to describe its relation to other stages of instructional development.

Early stages of instructional development supply the substance which the media selection process works with. Media selection for F-16 occurs following: (1) the generation of a job task inventory or task listing, (2) selection of a set of terminal training tasks, (3) generation of a list of difficult-to-operationalize behaviors called "goals", (4) generation of criterion-referenced objectives (CROs) to be used as terminal performance measurement points, and (5) generation of objectives hierarchies. The results of these processes taken together form a data base of instructional requirements for F-16 pilots (and also for F-16 instructor pilots, since the same data base was created for that position as well). The data base documents are used as inputs to the media selection process. They list the instructional events for which media needed to be selected. Those foundation documents and the details of their generation are described in separate F-16 project reports.

Concurrent with media selection and interacting with it, a process of syllabus-building or "sequencing" takes place. For sequencing, the same base of documentation from previous stages is used as an input. Sequencing is the process of arranging those instructional events taken from the CROs and objectives hierarchies in the order students encounter them in the course of instruction. Ideally, the sequence (syllabus) promotes the best obtainable gradual progression of student behavior from the time of entry into training to the point of mastery of all terminal course behaviors. Media selection and sequencing are closely related to each other. The order of instructional events in training often makes particular media selections more practical. Media selection decisions determine the types of instructional events and environments which can be used in the sequence. Special attention in both processes is given to adjusting the student's instructional experience to within certain parameters which the student will find tolerable or agreeable in terms of variety, pace, redundancy, and practical usability.

The results of the selection and sequencing processes are a course syllabus and a list of individual media assignments by instructional event. These documents lead to further instructional system development activities, although they represent by themselves a significant addition to the fundamental data base documentation referred to earlier. Throughout the lifetime of

the instructional system these documents should have a life of their own, changing as the documentation which acts as input to them changes (i.e., the task listing, goal analysis, CROs, objectives hierarchies) and in turn influencing other documents. An instructional system which does not maintain these documents, though derived through the application of good instructional development practices, cannot remain functional and efficient for long.

The media selection document, taken in conjunction with the syllabus serves several purposes. It serves as an inventory base during the actual production of instructional materials. Prior to that it serves as a base for calculating projections of the production organization and costs which will be required during production planning. For instance, the types and numbers of instructional presentations (called "segments") can be determined only after media selection, as well as projection of the number and types of media devices required to present instruction for a given volume of students. Indirectly, these figures lead to the partial projection of numbers and types of instructors, administrators, and technicians who will be required to staff the student Learning Center, simulator locations, media equipment repair facilities, and media revision, production, and reproduction facilities. All of these items have both short- and long-term financial implications. In fact, the financial impact of these decisions is the major cost factor in the instructional system operation.

2.3 Factors in Media Selection

In minimizing the costs and maximizing the benefits of media selections, many factors must be considered. Media selections must be a "best" solution based upon stated criteria, the optimization on a set of sometimes conflicting demands. "Make it inexpensive" often leads to different solutions than "make it effective," and frequently both disagree with "make it interesting." Ideally, the media selection process insures that each selection factor is properly considered in the decision-making process.

The media selection process described in Section 3.0 of this report is structured in such a way that consideration of these demands takes place in an orderly fashion and seeks to insure that each factor is considered in proportion to its relative importance to the development task at hand. Failure to consider all relevant factors in media selection, or undue and disproportionate emphasis on one factor can lead to wasteful spending or can produce media systems which are unpalatable to the student, difficult to use, instructionally ineffective, or any combination of these. Plentiful examples of each can be found in the history of instructional development.

The major factors which have been considered during the F-16 media selection process are listed below along with a statement of the relative priority of each within the F-16 context.

2.3.1 Ability to Implement Effective Instructional Strategies

The ability of a device to implement a specific instructional strategy is a factor of media selection too often diminished in importance, even though it should logically rival or even outweigh cost in determining which devices are selected. Media are preferred if they demonstrate a capability for implementing these strategies, and possible media combinations and reconfigurations are considered where strategies can not be accommodated in an attempt to produce media as capable as possible in implementing them. Characteristics of a media device which take part in the implementation of strategies are: (1) the ability to generate appropriate stimulus conditions, (2) the ability to receive student responses, (3) the ability to process those responses, and (4) the ability to provide appropriate counter-responses (feedback and/or subsequent stimulus conditions). Depending upon the strategy being used, these requirements may be simple or complex. They may call for the ability to present simple pictorial, detailed photographic, or complex moving computer-generated graphics as stimuli. They may call for the reception of responses from the student which are simple yes/no answers, or complex verbal expressions, or coordinated manipulation of aircraft-like controls. They may call for responses processing and feedback which ranges from simple correct answer comparisons followed by knowledge of results, to complex computerized calculation routines followed by simulated aircraft responses. In addition, all of these characteristics may be required under timed conditions and at varying levels of fidelity to real-world performance environments.

2.3.2 Cost

The cost factor is of extreme importance in media selections because cost is most often the only upward limiting factor. This is true of the F-16 project. Media selections entail not only immediate costs but delayed costs, some of which continue throughout the lifetime of the media system.

Figure 1 summarizes the costs associated with media device procurement and operation. The table identifies media costs during five main time frames: (1) during the design of media systems and instructional materials, (2) during the procurement of a media system, (3) during development of the media system and instructional materials, (4) during initial implementation of the system, and (5) during ongoing use of the media system and materials. It identifies major categories also, under which expenses might occur during each phase.

Media vary widely in the exact values of each entry in this table. Even for the same medium, expenses vary with differing training conditions, such as already-available resources, different geographic locations, differences in manpower availability,

TIME PHASE / CATEGORY OF COSTS	DESIGN	PROCUREMENT	DEVELOPMENT	INITIAL IMPLEMENTATION	ON GOING USE
Non-development personnel costs	–cost of equipment design personnel –cost of administrative personnel during design	–cost of personnel required to administer procurement	–cost of subject matter expert personnel –cost of development management and administration –cost of documentation of systems and its operation	–cost of instructional system administrative personnel –device instructor costs –cost of post-installation device testing and trouble-shooting –cost of initial device instruction and operation	–cost of instructional system administrative personnel –device instructor costs –device technical representative costs –repair personnel costs –cost of training device operators and instructors
Facilities costs	–cost of facilities design or remodeling –cost of planning use of existing facility	–cost of facilities for housing procurement team –cost of temporary procurement team sitting during travel	–cost of facilities to house development activities –cost of special development technical shops (e.g. VT studios, printing shops)	–facilities maintenance costs –costs of media device installation –facilities overhead & operating costs –cost of repair facility maintenance –equipment operating costs	–facilities repair costs –facilities overhead and operating costs –facilities maintenance costs –cost of repair facility maintenance –facilities periodic renovation cost
Equipment purchase				–cost of initial media devices and desk or carrel equipment –cost of initial spare parts inventory	–cost of replacement of worn media devices –cost of procurement for replacement aquisition –cost of spare parts for repair –cost of purchase of additional media devices to meet high student loads
Materials development	–cost of instructional materials design personnel	–cost of design personnel consultation and review during procurement	–cost of instructional development and production personnel –cost of producing supplies	–cost of duplication of instructional materials –cost of evaluation personnel	–cost of developing obsolete material replacement –cost of replacing worn materials with duplicates –cost of replacing student kept materials
Student expenses			–expenses incurred in trying out materials using typical students	–cost of maintaining students dislocated for media device use –student salary –student dislocation expense	

Figure 1 – Media-related Costs

and differing organizational patterns. Not all media require all of the listed expenses, but all media will have a subset of the expenses. The more sophisticated the medium, the more expenses are likely to be attached, in both the short and the long terms. For learning center media the acquisition costs are comparatively minor, but the maintenance costs for instructional materials can be substantial for aircrew training. For training devices, acquisition costs are often very large, even more so when multiple training sites and therefore multiple copies of a device are called for.

2.3.3 Attention- and Interest-Generating Qualities

Since media devices and the presentations made by them represent a main communication link during instruction, it is important not only that the message be clearly stated but that the presentation arouse attention and interest in the user. Inherent in most instructional strategies is an interaction between student and device that requires active participation by the student. This requirement for interaction can serve as an attention-generating tool. In addition, if the mode of interaction is interesting to the student or facilitates a student's personal learning goal, it can act as an interest-generating tool as well.

Many media selection decisions are made without considering the impact of the decision upon student attention and interest. Still others are made upon incorrect assumptions of what the developer thinks will be attention-getting or interesting to the student rather than upon data from student trials. Results of such selections are media selections which: (1) offend students because they are inappropriate to student's taste and learning styles, (2) bore students because they operate too slowly, because the student has no opportunity to interact, or because there is too much use made of one medium, (3) are a distraction to students because they require too much attention just for operation, or (4) are too fast for students' learning pace and cannot be controlled by the student, thus forcing the student to move at the presentation's rate or repeat the instruction--which some media do not allow.

2.3.4 Use of Standard Systems

Several potential benefits encourage utilization of existing, standard media systems where possible. Procurement of devices, maintenance service, acquisition of spare parts, and acquisition of replacement devices is facilitated when the media system being dealt with is well-known and widely-available. Moreover, for the production and reproduction of media presentations for such standard systems, specialized equipment and trained service personnel are much more likely to be available than for an exotic and little-used medium.

2.4 Constraints Upon Media Selection

Ungoverned by real-world constraints, the media selection process can produce interesting and effective but practically unusable solutions. Resource and personnel availability levels, costs, and personnel capability are all constraints which exist in nearly all media selection activities. Many other constraints exist as well due to policy, regulations, or limited supply of some critical resource. Some are hard constraints which cannot be changed, and some are soft. With the proper justification many can be modified.

Certain constraints existed at the onset of the F-16 media selection. Some of these were due to the late timing of the contractor's involvement in the F-16 development effort, and others were due to general USAF policies or programs. This section contains a study of the F-16 constraints related to media selection. Those listed are a subset of the constraints active with the context of the F-16 project. The total list of constraints and developer response to them, is contained in project report no. 15, "Program/System Constraints Analysis Report."

2.4.1 Directives, Regulations, and Manuals

Of the numerous manuals that impact F-16 aircrew training, four are particularly relevant to the media selection process: TACM 51-50, TACR 50-31, AFR 60-1, and TACM 51-5. TACM 51-50 establishes minimum Air Force standards for training and qualifying personnel performing duties in TAC assigned aircraft. Changes to this document may result in the addition, deletion, or modification of training tasks, resulting in a subsequent change in the media required to teach those tasks. An increase in TACM 51-50 standards could, for example, increase the requirement for aircraft and simulator time, while a decrease could reduce that requirement.

TACR 50-31 establishes a program for completing, maintaining, and disposing of training records generated in TAC units conducting syllabus training. More importantly, it provides academic testing procedures as well as simulator and flying performance evaluation, course training standards, and direction. Changes to the simulator and flying performance evaluation procedures may impact the use of simulators and aircraft for training purposes by altering the amount of training device time allocated to testing. AFR 60-1 establishes policy for the management of Air Force flying resources, and guidance applicable to the administration of flight management, aircrew training, and aircrew evaluation programs. Changes to this document could alter training tasks, instructional procedures, or testing criteria, all of which could impact the demands made upon instructional media.

TACM 51-5 establishes TAC policy on aircrew training, program management criteria, and administrative practices, and

outlines all aircrew ground training required to maintain aircrews at a high state of combat readiness. Changes to this document may alter training tasks, resulting in a subsequent change in the media required to teach those tasks.

2.4.2 Aircraft Availability

The F-16 aircraft is clearly the most essential training medium utilized by the system and its availability is critical. Ground based training limitations mandate that certain tasks be taught in the aircraft, while the early-on unavailability of sophisticated simulators places even greater demands on aircraft availability. The primary constraints of aircraft availability are as follows:

1. Delivery schedule delays, such as those currently projected for F-16 jet engines, may force some tasks to be trained using other media, or omitted from the training syllabus entirely.

2. The mix of F-16A and F-16B model aircraft impacts media selection by constraining the tasks that may be assigned to the F-16B aircraft. The current two F-16B to one F-16A ratio imposes no substantial limitation, provided the delivery schedule delays discussed in (1) above do not effect delivery of the two aircraft models differentially. This could limit the number of F-16B aircraft available for the numerous early flight tasks that require A/B model aircraft.

3. Developmental changes to the aircraft configuration--hardware and software--alter pilot tasks and may render some simulation training media outmoded. This characteristic of emerging weapon systems necessitates a fine-grained media selection procedure which incorporates a regular review of aircraft configuration and procedures.

4. The post program, with its associated source factors, will have a severe impact on aircraft availabiity if it is implemented in the F-16 RTU. Training tasks will have to be reassigned to alternate media in order to take full advantage of the period of high aircraft use, while allowing training to continue during the period of low aircraft use.

2.4.3 Programmed Flying Training

The programmed flying training plan provides basic information on student flow and sortie generation rates. Changes to this doucment affect media selection primarily in relation to the number of media devices required to support a given level of student throughput. Low generation rates will necessitate some tasks being trained in simulators rather than in the aircraft, while high generation rates will permit tasks to be shifted from the simulator to the aircraft.

2.4.4 USAF Manning Constraints

The number of instructor personnel available for F-16 training has a profound impact on the assignment of media to various training tasks. When instructors are available in large numbers, seminars, lectures, tutorial sessions, and other instructor-dependent media may be assigned liberally. When these individuals are in short supply, however, many objectives that would otherwise be taught through instructor interaction are relegated to student self-study media, such as workbooks, tape/slides and videotapes.

Changes to the instructor manning levels may be precipitated by changes to TACM 25-5, which contains procedures for computing and publishing aircrew, instructor, aircraft, and student requirements. this standard applies to all CCT and related training units within TAC.

2.4.5 Environmental Constraints

Environmental constraints refer to the characteristics of physical location, such as weather, altitude, geography, and airspace limitations, that limit the ability of F-16 aircraft to fly whenever and wherever they choose. These constraints affect only the aircraft, as all other training media are indoor resources and consequently unaffected by outdoor conditions.

1. TACR 55-16 establishes standard operational and weapons employment procedures for all tactical aircrews operating USAF F-16 aircraft. Each operational unit affected by TACR 55-16 then develops a supplement which is unique to its own location. For example, the 388th TFW supplement, Chapter VIII of TACR 55-16, sets forth requirements and procedures to follow for Hill AFB which are unique to Hill due to the altitude of the base and the summer temperatures, winter flying conditions, crosswind conditions, and so on. These differing conditions affect the amount of simulator practice that should be completed before actual aircraft task performance, as well as affecting the performance criteria associated with simulator and aircraft training objectives.

2. Conditions of weather variability will exist between the various F-16 training sites, resulting in a variation in the number and quality of flying training days available. This may require flexibility in the selection of media for flying training tasks, such that simulator exercises may replace or augment training flights that have been postponed or cancelled because of weather conditions.

3. It is assumed that local availability and configuration of operating ranges (ACMR/I availability) will vary from one training site to the next. This variability will apply to operational air space as well. Media selection should encourage the maximum use of these resources where they are

available, while ensuring maximum flexibility for those sites where such resources are either unavailable or limited to temporary TDY experience.

2.4.6 Safety

Safety is the primary design factor in virtually all phases of F-16 aircrew training, and media selection is no exception. The student must be given adequate experience in the relatively safe media, the simulators and F-16B model aircraft, before being allowed to operate the F-16A. AFM 127-1 provides guidance for the prevention and investigation of aircraft accidents and incidents, and all design changes will be compared to existing AFM 127-1 regulations for conformity.

2.4.7 Training Device Availability

The coordination of instructional development decision-making with the logistics of procuring complex media devices, for instance simulator equipment, has been difficult in the past as mentioned in the previous section. Often decisions on such devices take place before the arrival of instructional systems development personnel. Alternately, such decisions are often made by developers acting with inadequate information or analysis upon which to base their recommendation. The F-16 project has involved instructional developers at a very early phase of aircraft system design and implementation. Nonetheless, the deadlines for procuring simulators came earlier, and many features of the F-16 OFT/WST, CFT, and EPT were determined in advance of developer arrival.

A provision of the F-16 contract requires input from the instructional developer on the qualities and capabilities desired in the F-16 OFT. The formal portion of this input is contained in project report no. 22, "Recommendations for F-16 Operational Flight Trainer (OFT) Improvements". Though it has been found that some of the recommendations can be implemented in the final simulator system for F-16, many of them cannot because of the advanced stage reached in planning when the recommendations were produced. To the extent that the design of the simulator cannot be flexible to the developer's plans, a constraint is encountered which the developer must circumvent by adapting the instructional technique to the existing trainer capabilities.

Delivery deadlines for already-ordered training devices fall after the beginning of training of F-16 pilots. Availability of the OFT is likely to be four to six months following the start of training. Availability of the first CFT is scheduled for January 1979. The Egress Procedures Trainer is to be installed and working by January 1979. The interim training course will begin in January 1979.

Interim simulation capabilities of various types have been proposed by F-16 agencies. Each has attached to it a set of

constraints which will have major impact on F-16 training, particularly in the area of the syllabus sequence. Simulation capabilities operating at a distance from the central training site require extracts of the syllabus to be concentrated together for student work as the simulator becomes available. Moreover, instructors working at a distance from the main training site are likely to encounter communication problems with the main site. Students may also encounter the need for refresher instruction, depending upon the lag in simulator availability. Under these circumstances special configurations of the instructional materials, syllabus, and the instructor training and monitoring system may be called for.

Simulation capabilities operating at the main site but at a lesser degree of sophistication also require special interim syllabi and provision for later update of student capability as the full-capability simulator becomes available.

2.4.8 Ground-Based Training Limitations

Ground-based training limitations are defined by those training tasks that cannot be adequately taught on the ground. These limitations are of two primary types: Performance fidelity and subjective fidelity. Performance fidelity refers to the ability of a trainer or simulator to respond precisely as would the actual aircraft in the same siutation. In spite of the incredibly realistic simulation provided by some training devices, they still are unable to provide the full range of stimulus and response cues, especially in the area of cockpit visuals and the sensation of varying increments of forward velocity. Subjective fidelity refers to the inability of the individual student to forget that he is in a simulator on the ground instead of in an actual aircraft at altitude.

2.4.9 Preliminary Instructional Content

Because F-16 is a highly complex emerging weapon system, it can be expected that numerous changes will be made to the aircraft and to the procedures for its operational use. Changes in instructional content are dictated by these system and procedural changes that in turn dictate a change in instructional materials. Since changes will be constant, this indicates a constraint will be placed upon media presentations. It means they must be economical to revise, not only in turnaround time and personnel time, but in terms of special equipment or technical ability required to complete revisions.

2.4.10 Requirement for Premature Media Decisions

The difficulty of coordinating instructional development schedules with procurement schedules sometimes affects learning center media and simulator device decision-making. To allow the construction and equipping of learning center facilities to proceed on an operationally tolerable schedule, the numbers and

types of media devices and the architectural plan of the learning center for F-16's first training site had to be determined and announced before the media selection process was executed. These data were provided when requested and formed the basis for ordering learning center equipment and specifying learning center layout. Data are not available on whether the decisions were correct. The requirement for an early announcement, however, with the knowledge that the figures provided would be used to order media equipment, placed a constraint upon learning center media selections actually resulting. It is likely that the types of devices selected in that early selection were correct. It is not likely, however, that the numbers of media devices was as accurate in the light of continually-revised student load figures, actual media selections, and updates to critical task listing and objectives hierarchy documentation.

2.4.11 Absence of Funding for Additional Equipment

Despite the presence of previously-made media decisions, the possibility that media studies during instructional development might reveal additional desirable training devices was not ruled out. Such devices might include extra copies of already-ordered devices, modified already-ordered devices, or totally new devices. Should any of these prove desirable and funding for them not be found, that lack of funding would require revision of media and syllabus plans and would constitute a limitation. To the extent that recommendations for changes and additions to the training device inventory are couched in cost and effectiveness terms, a decision should be possible on the desirability of modifying the cost constraints.

2.4.12 Available Media Production Facilities

The ready access of some types of media production capability and the difficulty of obtaining expertise and equipment for other types consitutes a constraint upon certain F-16 media selections. The instructional materials created for F-16 must be maintained, updated, and replaced as required. Choosing media for which production facilities and personnel were difficult to obtain or train would be wasteful.

3.0 MEDIA SELECTION PROCESS

This section contains a step-by-step description of the media selection model used for F-16. The model contains a set of procedures along with the documentation aids necessary to support the decision-making process and record decisions made. The description which follows describes each step in the process separately at a level of detail that should enable the media selection process to be performed by personnel other than those originating the process.

A main feature of the model is its division into two main activities (1) selection of academic or learning center media, and (2) selecting of simulator-type training devices. Learning center media devices are oriented toward the imparting of information, the formation of new concepts, the learning and practice of new rules, and other cognitive exercises. The amounts of engineering involved in their selection is minimal. On the other hand, training devices which are not of this group, are not prepared mainly for the establishment of the conceptual and informational base but for the practice of actual job behaviors or behavior fragments in simulated job environments. These devices may be selected from a predetermined set of categories, or be engineered individually to create this job-related environment.

The general limitations in media selection methodology described in Section 1.0 of this report apply to both the learning center media selection and the training device selection. At present many questions of media selection have no firm answers. For the selection of learning ccenter media, few firm guidelines are provided to developers other than the rationale each one can establish. The selection of simulator-type training devices requires a body of coherent and consistent procedures for deriving training device specifications from task statements, such procedures are currently evolving but are by no means complete. The methodology in this report parallels the learning center media selection process. Training device design specifications are not addressed in this report.

Inherent in the procedures described in this report are certain assumptions:

1. Learning center media should be selected with due proportional emphasis upon the instructional strategy to be used during instruction. Several media selection models acknowledge this principle and attempt to define the elements of instructional strategy which figure in media decisions. For tne purposes of this report, a perspective of instructional strategy is taken which examines the individual instructional displays to be received by the student, classifies them, and utilizes systematic rules for their delivery to the student. This assumption is necessary

to avoid the evils of a cost-factors-only media selection model and to give balance to media selection by considering more of the factors relevant to media selection.

2. Alternate media selections produced by this model are assumed to be equivalent in instructional effectiveness. This is a difficult assumption which virtually all developers reject on the basis of intuition. Given the present state of the art in measuring instructional effectiveness, however, and the inability of instructional psychologists to produce any scale measuring units of effectiveness for comparison purposes, this assumption is necessary. All media selection models which take cost into account must make this assumption or else account for variable effectiveness through an estimation method.

3. The learning center and training device selection and design process can be improved through a process of validation which compares intended with actual outcomes in student performance. Though this sounds reasonable and desirable, the requisite research and real-world effectiveness studies have not been performed which supply the necessary data base. Cost figures and effectiveness indices are required which can be used as inputs to the selection and design process and relieve the best-guessing which otherwise must take place. The ability to select and design media through a process which involves considerations of cost and effectiveness requires either a beginning data base from which the figures can be derived or else an initial set of estimates which can be validated through experience. That data base does not presently exist for aircrew training devices and must be built before more precise trade-off studies can be made. This is emphasized as a critically important point if progress is to be made in defining the technology of media device design and selection. The ability to do this further assumes: (1) The existence of an adequate performance measurement and record keeping system within training systems which is capable of collecting student performance data of fine enough detail and with sufficient reliability to produce dependable conclusions, and (2) that a data recording system is in place on a continuous basis as training devices are used to gather time and usage data to be used in conjunction with the performance data.

Figure 2 contains a flowchart representation of the media selection process. The description which follows refers to the individual steps in this chart. The initial input to the media selection process is a complete list of criterion-referenced objectives (CROs) and instructional objectives from objectives hierarchy analysis. Objectives are grouped together during syllabus-building for combined mediation as instructional "segments". For the F-16, these groups did not average over three to four objectives per segment, and the types of objective (and thus

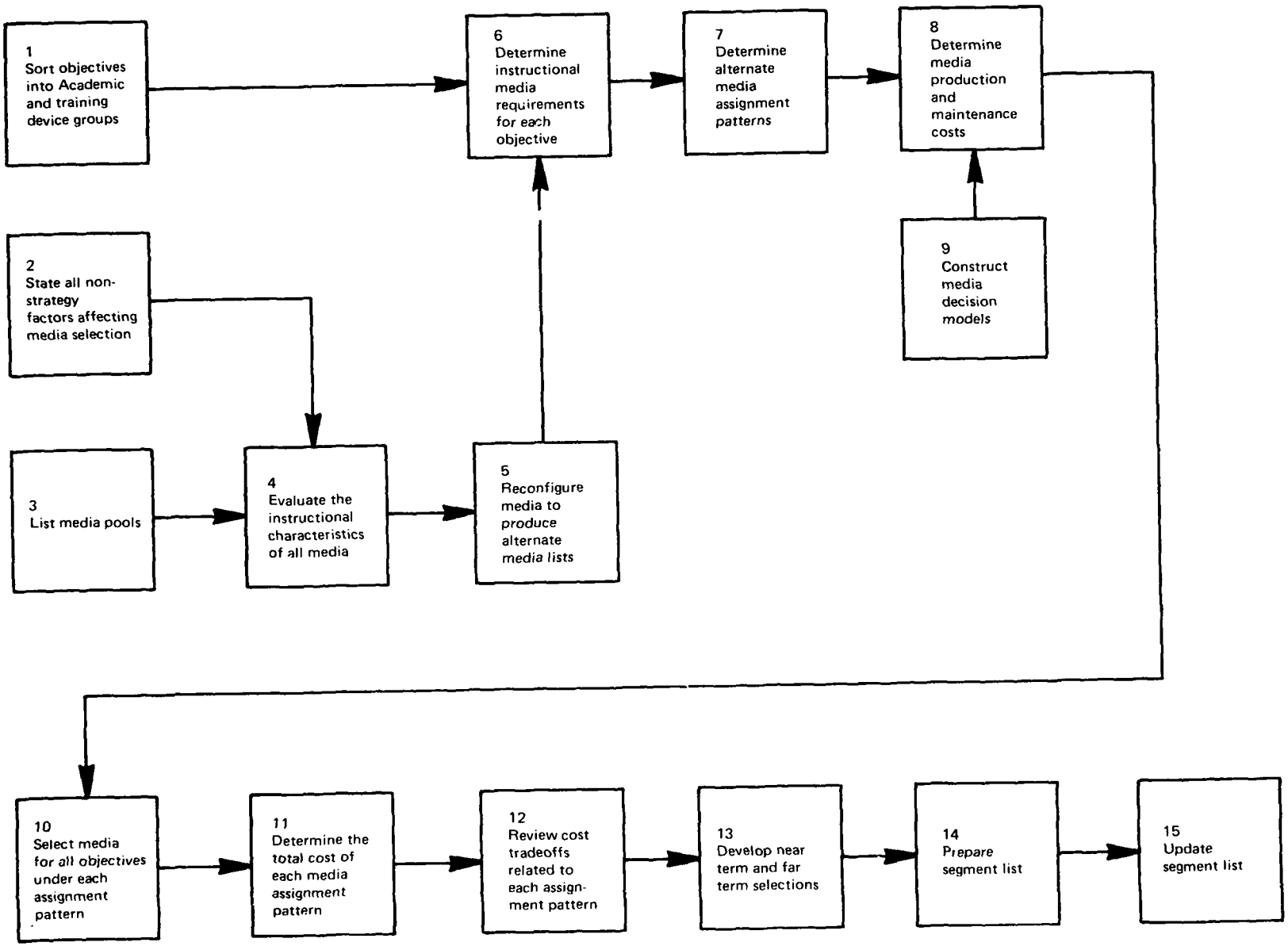


Figure 2-Flow Diagram of the Media Selection Model

the type of instructional strategy required to teach it) were not mixed within segments where it could be avoided. Though the word "objective" is used in this report to designate the instructional event to which a medium will be assigned, it should be understood that the eventual assignment will be an instructional segment. These segments make up the inventory of individual instructional events which must be mediated. The derivation of CROs and a description of their purpose is contained in F-16 Aircrew Training Development Project Report No. 5, "Derivations, Formatting, and Use of Criterion-Referenced Objectives (CROs) and Criterion-Referenced Tests (CRTs)". The same description for objectives hierarchy analysis is contained in project report no. 8, "Objectives Hierarchy Analysis Methodology Report".

A final note on bookkeeping requirements and the handling of changes is in order. In the execution of many ISD processes, particularly in large-scale instructional development where much information and data are generated, the bookkeeping process required becomes extremely important. It is unavoidable for the developer to become disoriented in the midst of a disorganized pile of data which he generates, but with an adequate bookkeeping process, it is easy to make large numbers of media decisions systematically. It is also easy, given appropriate bookkeeping practices, to insert changes to the body of the data base created by media selection. On the other hand, without such systematic procedures, especially for bookkeeping on decisions made, changes made can result in confusion, duplication of effort, loss of data, misplaced training requirements, and eventually wasteful results. The media selection process described in this document depends upon a bookkeeping system of forms and tables which collect and summarize data for individual objectives during the media selection process. These preserve a data trail for review and use by those charged with revision responsibilities. There is nothing sacred about the system of forms beyond the fact that they represent a bookkeeping system which is adequate to record the decisions made without losing them. Alternate methods of bookkeeping, particularly computerization of the process, are acceptable and desirable to the extent that they minimize the bookkeeping effort without decreasing the developer's ability to execute the process and keep from losing his orientation within the vast process of media selection.

3.1 Step 1: Sort Objectives into Academic and Training Device Groups

During this step, CROs and objectives were sorted into two classes. The first class was made up of all those objectives whose behavior require real or simulated job environments or equipment. This was the "training device" group of objectives. The second class contained objectives whose behaviors can be performed without such equipment or environments. This was the "academic" group of objectives.

There were two keys to making this discrimination. The first was the exact wording of the behavior. If the behavior read "perform the pre-takeoff inspection," then the behavior required equipment to be inspected. If on the other hand the behavior read "list the items to be inspected in the pre-takeoff inspection" no equipment was indicated, and the behavior could be accomplished outside of a real or simulated job setting.

Conditions and standards of an objective or CRO were the second key to making the discrimination. A condition may specify the type of display to be presented to the student. For instance, a condition could require the student to identify certain items from a radar return "given a photograph of a return". In this case the type of performance environment was specified. In the absence of such direction, a real-world environment was assumed.

The purpose of this sorting exercise was to determine which one of the two media selection matricies each objective would be processed through: Academic selection matrix or training device selection matrix. Worksheets to facilitate the bookkeeping chores of media selection were set up at this time. For each academic objective the appropriate numerical entry was made in Table 1, the academic objective analysis worksheet. For training device objectives, Table 2, the training device objectives analysis worksheet, was filled in. Later steps added data to these worksheets, which were simply set up during this step.

3.2 Step 2: State all Nonstrategy Factors Affecting Media Selection

The nonstrategy factors affecting media selection in any given situation can be so numerous as to defy a complete listing. There are certain general classes of constraints which need to be examined across all situations, since they can have serious effects on the potential successful implementation of the media if not taken into account. The most important of the constraints are listed below:

a. The acquisition cost of the media equipment.

b. The maintenance cost of the media equipment.

c. The characteristics of the media which enhance motivation and maintain attention and engagement of the student with the instructional task.

d. The "standardization" of the media device (ready availability, vendor support, documentation, etc.).

e. Environmental safety or other "special" support requirements.

OBJECTIVE REF. NUMBER / INSTRUCTIONAL REQ.										
CLASSIFICATION										
R/P (VERBATIM)										
R/P (PARAPHRASED)										
R/F (SYMBOL/NAME)										
R/F (FUNCT/LOC)										
R/F (LIM/TOL, CV)										
R/F (LISTS)										
R/F (SEQUENCES)										
U/C										
U/R										
DISPLAY										
AUDIO-VOICE										
AUDIO										
TACTILE										
KINESTHETIC										
VISUAL: VERB/TEXT										
VISUAL: PICTORIAL										
VISUAL: DIAG./DRAWINGS										
VISUAL: SPATIAL LAYOUT										
VISUAL: MOTION										
VISUAL: COLOR										
RESPONSE										
VERBAL/WRITTEN										
POINT/TOUCH/MARK										
MANIPULATE										
EVALUATION										
KEY SCORED										
INSTRUCTOR										
AUTOMATED										
FEEDBACK										
FREQ: IMMED/RESP										
FREQ: IMMED/ERROR										
FREQ: PERIODIC										
FREQ: POST-SESSION										
CONTENT: CORRECT ANSWER										
CONTENT: R/W ELAB										
CONTENT: BRANCH										
SPECIAL										
TEAM INTERACTION										
ENVIRONMENT										
MOTION										
TIME VARIABILITY										
LEARNER CONTROL										
COMMENT										

Table 1-Academic Objective Analysis Worksheet

	1 Panel Mockup	2 Cockpit Mockup	3 Stick & Throttle Trainer	4 SMS Trainer	5 Avionics Display	6 2-D Device	7 RWR Trainer	8 ICPT	9 CET	10 EPT	11 DSS	12 ASPT	13 SAAC	14 OFT	15 OFT + NVS	16 OFT + DRLMS	17 OFT + EW	18 WST	19 F-16 A Aircraft	20 F-16 B Aircraft	21 3D Model
PHYSICAL LAYOUT CHARACTERISTICS																					
Conformity with Shape																					
Between-Panel Spatial Relations																					
Within-Panel Spatial Relations																					
STIMULUS PROPERTIES-INTERIOR																					
Fidelity of Visual Stimulus																					
Fidelity of Aud (non voice)Stim																					
Fidelity of Kinesthetic Stimulus																					
Voice Stimulus Capability																					
STIMULUS PROPERTIES - EXTERIOR																					
Field of View																					
Proportion of Distant Obj																					
Coloration and Shading - Obj																					
Visual Sensation-Motion																					
Shape of Objects																					
Resolution - Detail Given Distance																					
MANIPULATIVE PROPERTIES																					
Fidelity of Manipulation																					
Timely Manip-Resp Connection																					
RESPONSE PROPERTIES																					
Fidelity of Interior Response																					
Fidelity of Exterior Response																					
INSTRUCTIONAL FEATURES																					
Instructor View of Stud. Displays																					
Stop Action Capability																					
Canned Demo Capability																					
Live Demo Capability																					
Conditions Reset Capability																					
EVALUATION FEATURES																					
R/W Feedback																					
Out of Tolerance Feedback																					
Instructor Feedback																					
Replay of Student Performance																					
OPPONENT																					
Maneuver Opponent																					
Non-Moving Opponent																					

Table 2-Training Device Objective Analysis Worksheet

f. Maintenance and acquisition cost for media presentations.

g. Suitability for environments in which training will take place.

These factors were utilized later in the procedure in making the final decisions between those subset members of the entire instructional media pool which met the threshold requirements of the initial selection process. The main factors influencing media selection for F-16 have been presented in Section 2.3 and 2.4 of this report.

3.3 Step 3: List the Media Pools

The next step was to generate the media pools from which instructional media would be selected. This required the development of two separate lists: Academic media and training device media. These inventories were developed by joint OTD team-contractor effort. In order to ensure a selection that would provide maximum flexibility, these pools consist of all instructional media within existing Air Force inventories as well as those projected to be available during the next decade. This allowed the OTD team to produce a media selection for the opening RTU class in March 1980, as well as the blueprint media selection for the future. This is discussed in Step 5, reconfigure media to produce alternative media lists.

ACADEMIC MEDIA POOL

1. Computer-assisted instruction plus lesson guide: An individualized digital computer-based instructional system whereby direct student-computer interface allows the automatic management and display of information to the student, the acceptance, processing and evaluation of student responses, the display of results, and the selection of subsequent learning events plus a worksheet containing the lesson (segment) identification number and title, an introduction, list of objectives, support information, graphics, practice items, and feedback to provide the student with a written record of all mediated presentations.

2. Computer-assisted instruction (CAI) plus videotape plus lesson guide: CAI plus lesson guide plus color television program stored on a tape cassett which may be operated by the student.

3. Computer-assisted instruction plus videotape plus part-task trainer plus lesson guide: CAI plus videotape plus lesson guide plus training hardware designed to provide hands-on

practice of a single or limited range of tasks which are cued and prompted by a videotape display.

4. Interactive part-task trainer plus lesson guide: Lesson guide plus part-task trainer that is wired to a computer to allow realistic responses to student manipulations. Cockpit gauges, for example, respond to student pressure on the throttle.

5. Random access slide plus lesson guide: lesson guide plus visual slide projection system that allow slides to be presented in any order, rather than following the order in which they are put into a cartridge.

6. Motion picture plus lesson guide: Lesson guide plus 16mm or super 8mm color film projection system.

7. Videotape plus lesson guide: See 2 above.

8. Videodisc plus lesson guide: Lesson guide plus color television program stored on a thin plastic disc instead of a tape (as in 2 above), allowing random access, freeze frame, and motion.

9. Tape/Slide plus learning guide: Learning guide plus system for presenting audiovisual information by means of an audio tape and a series of synchronized projected visual slides.

10. Suitcase projector with audio and both still and motion visual plus lesson guide: Lesson guide plus portable desk-top screen for viewing audiovisual film strip loops that include both still slides and limited motion sequences.

11. Workbook plus lesson guide: Lesson guide plus printed booklet which includes lesson identification number and title, introduction, objectives, core idea information, discussion of core idea information, graphics, practice, and feedback.

12. Color workbook plus lesson guide: Lesson guide plus workbook as in 11 above, but with color graphics.

13. Workbook plus slides plus lesson guide: See 5 and 11 above.

14. Workbook plus audio plus lesson guide: See 11 above plus audio tape recording that may be reviewed by individual student with tape/player/or presented to group as in 21, 26 and 30 below.

15. Programmed text plus lesson guide: Lesson guide plus a printed text containing a sequence of small frames of information and required a simple written response from the student.

16. Training manual plus lesson guide: Lesson guide plus off the shelf technical publication such as F-16 Dash One, operator guide or maintenance manual.

17. Model/Actual equipment plus lesson guide: Lesson guide plus scale model or actual item of operational equipment used for training purposes.

18. Cockpit familiarization trainer (CFT) plus lesson guide: Lesson guide plus F-16 3-dimensional life-size cockpit mockup with screen for tape/slides located where head-up display would go.

19. CFT plus tape/slide plus lesson guide: See 9 and 18.

20. Lecture plus lesson guide: Lesson guide plus formal, stand-up podium expository presentation to a large class (10 or more).

21. Lecture plus audio and lesson guide: See 14 and 20.

22. Lecture plus visual motion plus lesson guide: See 20 plus 2-videotape or 6-motion picture above.

23. Lecture plus model/actual equipment plus lesson guide: See 17 and 20 above.

24. Lecture plus student response system plus lesson guide: See 20 above plus desk-mounted responders that allow all students to respond to instructor questions simultaneously and consequently guide lecture delivery based on real-time student comprehension.

25. Tutorial plus lesson guide: Lesson guide plus one-on-one student-instructor interaction loosely structured around a flexible format of objectives.

26. Tutorial plus audio plus lesson guide: See 21 and 25 above.

27. Tutorial and visual motion plus lesson guide: See 22 and 25.

28. Tutorial plus model/actual equipment plus lesson guide: See 23 and 25 above.

29. Seminar plus lesson guide: Lesson guide plus informal discussion loosely structured around a firm format of objectives for a small class (2 to 9 students).

30. Seminar plus audio plus lesson guide: See 21 and 29.

31. Seminar plus visual motion and lesson guide: See 22 and 29 above.

32. Seminar plus model/actual equipment plus lesson guide: See 23 and 29.

TRAINING DEVICE MEDIA POOL

1. Panel mockup
2. Cockpit mockup
3. Stick and throttle trainer
4. Stores management system trainer
5. Avionics display
6. 2-dimensional isolated system device
7. Radar warning receiver trainer
8. Interactive CFT
9. CFT
10. Egress Procedures Trainer (EPT)
11. Dynamic system simulator
12. Simulation air-to-air combat trainer
13. Operational Flight Trainer (OFT)
14. OFT and night visual system trainer
15. OFT and Digital Radar Land Mass System
16. OFT and electronic warfare trainer
17. Weapons System Trainer (WST)
18. F-16A aircraft
19. F-16B aircraft
20. Advanced Simulator for Pilot Training (ASPT)

3.4 Step 4: Evaluate the Instructional Characteristics of All Media

Once the two media pools have been identified, each must be evaluated in terms of its training capabilities. This process was completed by developing a media-by-capabilities matrix. The media in each media pool were listed across the top of the

matrix, while an inventory of relevant training capabilities was listed down the side. This yielded a box, or cell, for each medium for each capability. These cells were then filled with numbers representing a 1-5 rating. If the medium did not possess or exhibit the capability the cell was left blank. If the medium exhibited the capability to a very limited degree, it was given a rating of 1. If, on the other hand, it exhibited that capability to a great degree, it was rated 4 or 5. The scale was as follows:

5--IDEAL: This is the best medium for the objective. Its efficiency, effectiveness, and flexibility are outstanding. The scope is adequate for the full range of possible instructional instances and there is a likelihood of positive affect.

4--DESIRABLE: This is a good medium for the objective. It is efficient, effective, and flexible. A broad range of possible instructional instances are available, and there is potential for positive affect.

3--GOOD: This medium will teach the objective adequately. It is reasonably effective, efficient, and flexible. It will provide the most commonly required instructional instances.

2--ADEQUATE: This medium is acceptable, but weak. The scope and flexibility are limited and both effectiveness and efficiency are poor. There may be a strong dependence on secondary media.

1--POOR: This is the medium of last resort. Effectiveness, efficiency, scope and flexibility are poor. There may be almost complete reliance on secondary media and there is a potential for negative effect.

The academic and training device media were analyzed on the basis of two very different sets of training capabilities. The capabilities rated for the academic and training device media were as follows:

3.4.1 Display Characteristics

Those features which are an integral part of the media output.

1. Audio-voice: An output of both human as well as nonhuman audible signals.

2. Audio: An output of nonhuman audible signals (i.e., music, tones, etc.).

3. Tactile: A display which feels the same to the touch as real world equipment (e.g., knob on the display of a cockpit

training panel feels the same to the touch as the same knob on the actual equipment).

4. Kinesthetic: Equipment on the display responds the same way to the touch as real world equipment (e.g., a switch on the display responds exactly like the switch on the aircraft).

5. Visual: The following display characteristics are concerned with the visual display seen by the student.

   a. Text: The display includes printed material.

   b. Pictorial: The display includes photographs.

   c. Diagrams/Drawings: The display includes line art or full art drawings.

   d. Spatial Layout: The display has the exact same dimensions/proportions as the real equipment it depicts.

   e. Motion: The display includes movement.

   f. Color: The display includes color.

3.4.2 Response

The type of student input accepted by the medium.

1. Verbal/written: The student response may be either orally given or handwritten.

2. PTM--The student may respond by pointing (P), touching (T), or marking (M) an item.

3. Manipulate: The student may respond by operating or controlling a device or piece of equipment.

4. Covert: The student's response is undetectable (i.e., he conceives the answer but does not make an observable response. (NOTE: This category of response has proved to be generally impractical, in that there is no method of detecting whether the student's answer is correct or incorrect. Therefore, it has not been used in developing the F-16 training system.

3.4.3 Evaluation

The method of delivering a response to the student on the correctness or incorrectness of his answer.

1. Instructor: A response to the student's answer is given by the instructor.

2. Automated: The response to the student's answer is generated by the medium.

3. Peer: The response to the student's answer is given by a fellow student. (NOTE: This is generally not acceptable as key.

3.4.4 Feedback

The type of response the student receives after answering a test or practice item.

1. Frequency: How often feedback is presented to the student.

   a. Immediate/Response: The student receives feedback immediately after answering a test/practice item.

   b. Immediate/Error: The student receives feedback immediately after answering a test/practice item incorrectly.

   c. Periodic: The student receives feedback after answering a predetermined number of test/practice items.

   d. Post-Session: The student receives feedback after a complete training session.

2. Content: The information provided to the student during feedback.

   a. Correct Answer: The student is given the right answer after responding to a question incorrectly.

   b. Right/Wrong Elaborated: The student is given information as to why he answered a question correctly or incorrectly.

   c. Branch to New Display: The student receives new information based on the correctness or uncorrectness of his answers (e.g., If the student answers correctly the display may branch to a new lesson. If the student answers incorrectly the display may branch to additional practice items or a "HELP" segment).

3.4.5 Special Requirements

Unusual needs required by a specific lesson which must be performed by the selected medium.

1. Crew/Team Interaction: The need for the media to allow interaction required between crew members and the flight team (e.g., interaction between a pilot and a navigator).

2. Environment: The need for the media to present extraordinary conditions which the student needs to respond to (e.g., taking off during unfavorable weather).

3. Motion: The need for the media to present normal and abnormal movement which require a specific response from the student (e.g., the student may need to make certain responses while an aircraft is banking).

4. Time Variability: The need for the media to present information in fast or slow motion.

5. Learner control: The need for the student to regulate his own learning by controlling content, sequence, and rate.

TRAINING CAPABILITIES OF ACADEMIC MEDIA

1. Display characteristics: Those features which are an integral part of the media output.

   A. Audio-voice: An output of both human as well as nonhuman audible signals.

   B. Audio: An output of nonhuman audible signals (i.e., music, tones, etc.).

   C. Tactile: A display which feels the same to the touch as real world equipment (e.g., knob on the display of a cockpit training panel feels the same to the touch as the same knob on the actual equipment).

   D Kinesthetic: Equipment on the display responds the same way to the touch as real world equipment (e.g., a switch on the display responds exactly like the switch on the aircraft).

   E. Learner control: The need for the student to regulate his own learning by controlling content, sequence, and rate.

TRAINING CAPABILITIES OF ACADEMIC MEDIA

1. Physical layout characteristics: The three categories within this class define the degree of realism with which the cockpit or other training environment is laid out.

   A. Conformity with shape: A high rating on this characteristic indicates a training device in which the actual flight equipment is simulated; e.g., round dial with a needle is shown as a round dial and not a digital readout.

   B. Between-panel spatial relations: A high rating on this characteristic indicates a training device where the absolute distance between major panels and subpanels is a close approximation of the real equipment.

C. Within-panel spatial relations: A high rating on this characteristic indicates a training device in which the absolute distance between items on an individual panel is a close approximation of the real equipment.

2. Stimulus properties--interior: These characteristics define the fidelity with which the control indicators and displays located within the cockpit present information to the student.

   A. Fidelity of visual stimulus: This characteristic defines the fidelity of indicators and displays which present information by visual means.

   B. Fidelity of audio (nonvoice) stimuli: This characteristic defines the fidelity with which the trainer presents nonvoice audio stimuli such as the AIM-9 Missile Aural Tone.

   C. Fidelity of kinesthetic stimulus: This characteristic defines the degree to which the "feel" of operating the trainer's interior controls correspond to the "feel" of operating the controls of the actual equipment.

   D. Voice stimulus capability: The presence of this characteristic indicates the student can receive spoken communication from the instructor.

3. Stimulus properties--exterior: This class defines the fidelity with which the environment external to the actual aircraft is replicated in the training device.

   A. Field of view: A high rating on this characteristic indicates a field of view which is large enough to approximate the field of view of the student in the actual equipment.

   B. Proportion of distant objects: A high rating on this characteristic indicates a visual system with enough resolution so that objects at a great apparent distance appear to be in their true proportions and are of the correct apparent size.

   C. Coloration and shading--objects: A high rating on this characteristic indicates realistic color and shading so that apparent depth is enhanced.

   D. Visual sensation--motion: A high rating on this characteristic indicates a fully dynamic display in which apparent motion is of high fidelity. A lower rating on this would indicate either stop action motion or still visuals.

E. Shape of objects: A high rating on this characteristic indicates no matter what the apparent aspect angle of the visual display, the object display will be of the correct proportion.

F. Resolution--detail given distance: A high rating on this characteristic indicates that the relationship between the amount of detail with which an object is displayed and the apparent distance the student is from that object approximates the amount of detail that would be visible from the actual equipment in that same situation.

4. Manipulative properties: The manipulative properties of a training device define the ways and the fidelity with which a student can interact with the controls of the trainer.

   A. Fidelity of manipulation: A high rating on this characteristic indicates trainer control switches that closely approximate the controls of the actual equipment such that they are manipulated in the same manner.

   B. Timely manipulation--responds connection: A high rating on this characteristic indicates that the training device responds to student with a time lag which closely approximates the time lag present in actual equipment.

5. Response properties: This class defines the realism with which the training device responds to student actions.

   A. Fidelity of interior response: This characteristic defines the fidelity with which the training device responds to student actions. It differs from class two, above in that it refers to changes in the interior state of the training device which are student generated as opposed to device generated.

   B. Fidelity of exterior response: This characteristic refers to the fidelity with which changes in the external environment based on student actions are represented.

6. Instructional features: The list of characteristics which comprise this class is not an exhaustive one; rather, it is a catalog of special instructional features which required significant hardware engineering, but which are necessary for instruction in a reasonable large subset of in-flight tests.

   A. Stop action capability: The presence of this characteristic gives the instructor the ability to halt the flow of real time at any point in the training device sessions so that the student may study the displays and situation at that critical instant.

B. Canned demo capability: The presence of this characteristic means that the training device possesses the capability of presenting stored scenarios. The higher the rating on this characteristic, the greater the degree of self-stimulation of displays and controls that is possessed by the training device.

C. Live demo capability: The presence of this characteristic indicates that the training device is capable of being manipulated externally by the instructors such that the student can see the sequence of events and actions in any scenario that the instructor can imagine. A high rating on this characteristic can be likened to the training possibilities that exist in a dual control aircraft.

D. Conditions reset capability: The presence of this characteristic indicates that the training device has the capacity to store the particular set of parameters such that upon the command of the instructor, the state of all displays and controls can be returned to that stored state of conditions. The high ratings on this characteristic indicate either larger numbers of initial conditions which may be stored and/or larger numbers of parameters which are stored within any one set of conditions.

7. Evaluation features: This class is similar to the preceding one in that the list of characteristics do not exhaust the class, rather they are characteristics whose presence are often desired/required due to the increase in training efficiency they engender by providing the immediate and sufficient feedback to the student and/or the performance evaluation capabilities they provide which would be lacking without this characteristic.

A. Instructor view of student displays: Ratings on this characteristic define the extent with which the displays available to the student are duplicated for the benefit of the instructor to use in monitoring student performance.

B. R/W feedback: The presence of this characteristic indicates that the training device has a capability of automatically monitoring student performance and indicating to the student whether that performance is acceptable or unacceptable. No elaboration is provided; merely indication of behavior.

C. Out of tolerance feedback: The presence of this characteristic indicates that the training device has the capability of automatically monitoring student performance and indicating to him when that performance does not meet with a preset standard as well. High

ratings on this characteristics indicate the increased accuracy with which the training device can present the student with the degree to which he has failed to meet a given standard.

D. Instructor feedback: The presence of this capability indicates that the instructor is present with a student and can monitor his performance such that the human judgement factor is included in the feedback equation.

E. Replay of student performance: The presence of this characteristic indicates that the training device has the capability of storing a record of the actions taken by the student such that on command it can "replay" those actions in terms of a real time duplication of displays and control movements so that the student may reveal an exact record of his own performance.

8. Opponent: This class defines the amount of combat training possible with a device. It's characteristic is to define the type and capabilities of opponents which the student can meet in the training device.

A. Maneuvering opponent: The presence of this characteristic indicates that the training device is able to present the student with an opponent who will maneuver in response to the student's own control inputs. The higher the rating in this characteristic, the higher the fidelity with which the maneuvering opponent is simulated.

Table 3 presents the media selection matrix for academic media, while Table 4 presents the matrix for training device media. Again, an empty cell indicates that the medium does not possess the training capability at all, a 1 suggests that the medium possesses it to a very limited degree, and a 5 indicates that the medium excells in that capability.

3.5 Step 5: Reconfigure Media to Produce Alternate Media Lists

Once the strategy and nonstrategy factors have been stated which will limit or constrain media selection, the master list of all available media can be scanned for media which do not support the factors, or which are outside the bounds of the constraints. These media are then designated on the candidate media list. Some possible reasons for designating a medium might be:

- The immediate or long-range costs associated with a medium for production, repair, acquisition, or operation are prohibitively high when weighed against the expected benefits.

ACADEMIC MEDIA

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
	CAI + Lesson Guide	CAI + Videotape + LG	CAI + Videotape + Part Task Trainer + LG	Interactive Part Task Trainer + LG	Random Access Slide + LG	Motion Picture + LG	Videotape + LG	Videodisc + LG	Tape Slide + LG	Suitcase Projector + LG	Workbook + LG	Color Workbook + LG	Workbook + Slides + LG	Workbook + Audio + LG	Programmed Text + LG	Training Manuals + LG	Model/Actual Equipment + LG	CFT + LG	CFT + Tapeslide + LG	Lecture + LG	Lecture + Audio + LG	Lecture + Visual Motion + LG	Lecture + Model/Actual Equipment + LG	Lecture + Student Response System + LG	Tutorial + LG	Tutorial + Audio + LG	Tutorial + Visual Motion + LG	Tutorial + Model/Actual Equipment + LG	Seminar + LG	Seminar + Audio + LG	Seminar + Visual Motion + LG	Seminar + Model/Actual Equipment + LG	DISPLAY
	2	3	3			3	3	3	3	3				3					3	4	4	4	4	4	4	4	4	4	4	4	4	4	Audio-Voice
	5	5	5			3	4	5	5	5				5					5		5	4			5	4			5	4			Audio
			5														5	5	5				3					5				4	Tactile
			5														5	5	5				3					5				4	Kinesthetic
																																	Visual
	5	5	5	4	4	2	2	4	4	4	5	5	5	5	5	5	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	Text
	3	3	3	5	5	2	2	5	5	1	4	4	5	4	4	4	1	1	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Pictorial
	3	3	3	5	5	2	2	5	5	1	4	4	5	4	4	4	1	1	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Diagrams/Drawings
																	5	5	5				3					5		4		4	Spatial Layout
	1	5	5			5	5	5		2												5				5					3		Motion
	5	5	5	4	5	5	5	5	5	5		5	5				4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	Color
																																	RESPONSE
	5	5	5	1	3	1	1	2	1	1	4	4	4	4	4	1	1	1	1	2	2	2	2	3	5	5	5	5	4	4	4	4	Verbal/Written
	4	4	5	5	1	1	1	1	1	1	2	2	2	2	2	1	5	5	5	1	1	2	3	2	3	1	4	5	2	1	3	4	P-T-M
			5	5													5	5	5				3					5				4	Manipulate
																																	Covert
																																	EVALUATION
																				3	3	3	3	4	5	5	5	5	4	4	4	4	Instructor
	5	5	5	5				3		2														2									Automated
																																	Peer
	4	4	4	4	3	3	3	3	3	3	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Student Self Scored
																																	W/Feedback
																																	Frequency
	5	5	5	5	4	1	1	4	1	1	2	2	2	2	4	1	1	1	1	1	1	1	1	5	5	5	5	5	1	1	1	1	Immed/Response
	5	5	5	5				3		3					3									1	5	5	5	5					Immed/Error
	5	5	5	5	4	1	1	4	4	4	4	4	4	4	4	3	2	2	2	5	5	5	5	5	5	5	5	5	5	5	5	5	Periodic
	5	5	5	5	4	1	1	4	4	4	4	4	4	4	4	3	2	2	2	5	5	5	5	5	5	5	5	5	5	5	5	5	Post-Session
																																	CONTENT
	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Correct Answer
	5	5	5	5	4	1	1	4	1	1	1	1	1	1	4					2	2	2	2	4	5	5	5	5	3	3	3	3	Rt/Wrong Elaborated
	5	5	5	5	4			4		3					3					1	1	1	1	5	5	5	5	5	2	2	2	2	Branch to New Displa
																																	SPECIAL REQS.
																																	Crew/Team Int.
																																	Environment
																																	Motion
		5	5	5	5		5	5	5		4																						Time Variabilities

Table 3-Academic Media Selection Matrix

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Panel Mockup	Cockpit Mockup	Stick & Throttle Trainer	SMS Trainer	Avionics Display	2-D Device	RWR Trainer	ICPT	CFT	EPT	DSS	ASPT	SAAC	OFT	OFT + NVS	OFT + DRLMS	OFT + EW	WST	F-16 A Aircraft	F-16 B Aircraft	3D Model	
																					PHYSICAL LAYOUT CHARACTERISTICS
5	5	5	3	5		5	5	5	5	4	5		5	5	5	5	5	5	5	5	Conformity with Shape
	2						5	5	5	2	5		5	5	5	5	5	5	5	1	Between-Panel Spatial Relations
5	5	5	4	4	3	5	5	5	5	3	5		5	5	5	5	5	5	5	5	Within-Panel Spatial Relations
																					STIMULUS PROPERTIES-INTERIOR
3	3	5	4	4	2	5	4	3	5	3	4		5	5	5	5	5	5	5	5	Fidelity of Visual Stimulus
					1	5	1		4		2	2	4	4	4	4	4	5	5	1	Fidelity of Aud (non voice)Stim
									2			3	3	3	3	3	4	5	5		Fidelity of Kinesthetic Stimulus
2	2	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	3	3	2	Voice Stimulus Capability
																					STIMULUS PROPERTIES - EXTERIOR
										1	3	2		1			4	5	5		Field of View
										1	3	2		1			4	5	5		Proportion of Distant Obj
										1	3	2		1			4	5	5		Coloration and Shading - Obj
										1	3	2		1			4	5	5		Visual Sensation-Motion
										1	3	2		1			4	5	5		Shape of Objects
										1	3	2		1			4	5	5		Resolution - Detail Given Distance
																					MANIPULATIVE PROPERTIES
2	2	4	4	2		4	4	4	4	3	4		5	5	5	5	5	5	5	5	Fidelity of Manipulation
		3	4	3	1	4	3		3	4	4	1	4	4	4	4	5	5	5	1	Timely Manip-Resp Connection
																					RESPONSE PROPERTIES
		2	4	3	1	4	1		2	3	4		5	5	5	5	5	5	5		Fidelity of Interior Response
									1	2	3	4		2			4	5	5		Fidelity of Exterior Response
																					INSTRUCTIONAL FEATURES
5	5	5	5	5	5	5	5	5	4	5	3	3	4	4	4	4	4	2	3	5	Instructor View of Stud. Displays
1	1	1	1	1	1	3	3	1	3	3	4	5	5	5	5	5	5			1	Stop Action Capability
					3	5	3						3	3	3	3	4				Canned Demo Capability
2	2	2	4	5	2	5	2	2	2	3	1	4	1	1	1	1	1	1	5	5	Live Demo Capability
2	2	2	2	2	2	2	2	2	3	2	5	5	5	5	5	5	5	1	1	4	Conditions Reset Capability
																					EVALUATION FEATURES
			4	1	5		5		1	1	1	1	1	1	1	1	1	1	1		R/W Feedback
					2		2		1		4	2	4	4	4	4	4				Out of Tolerance Feedback
5	5	5	5	5	5	5	5	5	5	5	3	4	4	4	4	4	4	2	4	5	Instructor Feedback
					2		2					4	5	5	5	5	5				Replay of Student Performance
																					OPPONENT
												4	1	1			5	4	4		Maneuver Opponent
										1		1	1	1	4		5	4	4		Non-Moving Opponent

Table 4-Training Device Media Selection Matrix

- The expertise or equipment required to produce and modify instructional presentations are not readily available.

- The medium does not fall within the limits set by the constraints.

- The medium is as yet experimental in nature and has unknown operational properties (durability, student acceptance, etc).

- The production time for presentations in this medium is too long.

- The medium is not durable and is subject to breakdowns.

- The medium makes demands of students that are beyond their normal range of interest or ability.

- The medium is too complex to use and is likely to require too much of the student's time or attention for operation.

These are suggested media designation criteria and do not comprise an exhaustive list. A complete list for a given media selection will depend upon factors local to the project. In making designations some judgement is required. Decisions are not likely to be clear-cut, and some trade-offs may be considered before designating media. For instance, some media may be clearly unaffordable, too delicate, not portable, or in some other way beyond practicality. Other media, on the other hand, may appear to be out of bounds on some factors but yet have such a strong positive recommendation from others that they may be retained, unlabeled on the list. A medium may be retained which is expensive in acquisition but yet can implement instructional strategies far better than other media. A medium which has found itself in this situation in the past is computer-assisted instruction (CAI). The initial cost of a CAI system is often troublesome, but the attraction of the strategy versatility of a computer and the side uses of a computer, for instance, in computer-managed instruction (CMI), make a CAI system very desirable despite cost. (Surprisingly, when total actual costs are compared for various media, some CAI systems turn out to be comparatively less expensive. This is because actual costs are in fact higher than usually estimated and CAI costs lower than expected.) This combination could cause a medium to be left on the candidate list undesignated, despite some factors legislating against it. This has been the case for F-16. When media are for some reason desirable but cannot fit the requirements imposed by the factors, reconfiguration of a medium by combination with another medium or by different patterns of use should be considered. Two media used in combination may be more effective than a single medium.

The goal of this reconfiguration was to produce two media selections, one for the March 1980 syllabus and one for a

futuristic unconstrained syllabus. Project personnel referred to the 1980 media selection as the "real world" selection and to the futuristic selection as the "2001" selection. The F-16 OTD team reviewed the media pools for academic and training device instructional media, designating with an asterisk (*) those which would not be available for the real world syllabus in 1980, but would probably be available for the 2001 syllabus. These designations are listed below:

ACADEMIC MEDIA POOL WITH MEDIA UNAVAILABLE FOR 1980 IMPLEMENTATION DESIGNATED WITH AN ASTERISK (*)

1.* CAI plus lesson guide

2.* CAI plus videotape plus lesson guide

3.* CAI plus videotape plus part-task trainer plus lesson guide

4.* Interactive part-task trainer plus lesson guide

5.* Random access slide plus lesson guide

6. Motion picture plus lesson guide

7. Videotape plus lesson guide

8.* Videodisc plus lesson guide

9. Tape/Slide plus lesson guide

10.* Suitcase projector with audio and both still and motion visual plus lesson guide

11. Workbook plus lesson guide

12.* Color workbook plus lesson guide

13. Workbook plus slides plus lesson guide

14. Workbook plus audio plus lesson guide

15. Programmed text plus lesson guide

16. Training manual plus lesson guide

17. Model/Actual equipment plus lesson guide

18. Cockpit Familiarization Trainer (CFT) plus lesson guide

19. CFT plus tape/slide plus lesson guide

20. Lecture plus lesson guide

21. Lecture plus audio plus lesson guide
22. Lecture plus visual motion plus lesson guide
23. Lecture plus model/actual equipment plus lesson guide
24. Lecture plus student response system plus lesson guide
25. Tutorial plus lesson guide
26. Tutorial plus audio plus lesson guide
27. Tutorial and visual motion plus lesson guide
28. Tutorial plus model/actual equipment plus lesson guide
29. Seminar plus lesson guide
30. Seminar plus audio plus lesson guide
31. Seminar plus visual motion and lesson guide
32. Seminar plus model/actual equipment plus lesson guide

TRAINING DEVICE MEDIA POOL WITH MEDIA UNAVAILABLE FOR 1980 IMPLEMENTATION DESIGNATED WITH AN ASTERISK (*)

1. Panel mockup
2. Cockpit mockup
3. Stick and throttle trainer
4. Stores management system trainer
5. Avionics display
6. 2-dimensional isolated system device
7. Radar warning receiver trainer
8.* Interactive CFT
9. CFT
10. Egress Procedures Trainer (EPT)
11. Dynamic system simulator
12. Simulation air-to-air combat trainer

13.* Operational Flight Trainer (OFT)

14.* OFT and night visual system trainer

15.* OFT and Digital Radar Land Mass System

16.* OFT and electronic warfare trainer

17.* Weapons System Trainer (WST)

18. F-16A aircraft

19. F-16B aircraft

20. Advanced Simulator for Pilot Training (ASPT)

3.6 Step 6: Determine Instructional Media Requirements for Each Objective

This step required the media selection and sequencing staff to go through the complete objectives hierarchies for both the academic and hands-on syllabus and to make a series of specific instructional determinations as to the instructional display requirements, response requirements, evaluation requirements, feedback requirements, and other special requirements imposed by each individual instructional objective in terms of both the specific content characteristics to be mastered (visual vs verbal concept, etc.) and the instructional strategy implied by the instructional classification of the objective. This data was collected utilizing structured data collection instruments, designed by the media selection team. Table 5 represents a partially completed academic objective analysis worksheet, while Table 6 depicts a partially completed training device, or hands-on, analysis worksheet.

The left column of the worksheet represents the unique identification number associated with each objective. This allows each objective to be designated without writing it out. The check marks to the right of each objective number indicate the minimal instructional requirements of that particular objective. If color or motion are absolutely required to teach the objective, for example, they receive a check. If they are unnecessary, they do not receive a check. The pattern of checkmarks associated with an objective indicates, in the opinion of the contractor and the OTD team, the minimal requirements an instructional medium must provide in order to teach that objective.

Some general guidelines may be provided for specifying the requirements. For display capability choose the least complicated or expensive level of effort which will accomplish the instruction. Unfortunately there is some subjectivity in this decision. The instruction to choose the least complicated

capability arises from the tendency of media research to find little or no difference in learning attributable to more complex or finely finished instructional displays (Travers, 1970). Simple line drawings are in many cases as instructionally effective as complex renditions or even photographs. There is even some evidence that during training the more complex the display, the more difficult it is for the student to detect the main message or salient points.

For pace and control decisions, student control should be favored, depending upon the anticipated motivation and self-directedness of the students. Research in military training environments has found time efficiencies attendant to students being given control of instructional order and speed (Walker, 1978). For students who are highly motivated and self-directed this effort would be expected to be very strong. On the other hand, for dealing with low-motivation students or students who are not self-directed, student control may be inappropriate.

The logic of the media selection process should now become apparent. First, the capabilities of the media are determined. Second, the requirements of the objectives are determined. Third, the computer matches the capability of each medium to the requirements of each objective, yielding for each objective a prioritized list of those media most ideally suited for presenting each objective.

Once data were collected on all instructional objectives, both trainer and academic, they were coded and entered into a high-speed computer. It should be noted that the collection of over 25,000 data points was an extremely time consuming task, and partially offset the advantage gained by utilizing the data processing capability. The computer matched the requirements of each objective with the capabilities of each medium, yielding for each objective a prioritized list of canadidate media.

3.7 Step 7: Determine Alternate Media Assignment Patterns

At this time, the team determined six different media mixes for comparison. As a preliminary to this step, a complete listing was run comparing the instructional requirements for each individual objective to the instructional capabilities of each of the media in the initial media pool. This resulted in a prioritized list of all media which met minimal instructional requirements for the objective. This list in once sense represents a seventh media pattern, albeit not a realistic one. On the basis of an analysis of the constraints generated by the training support requirements analysis process, including but not limited to the constraints listed in Sections 2, 3, and 2.4, six different alternative media mixes were selected for detailed comparison on the basis of instructional effectiveness, acquisition cost, maintenance cost, instructional motivation characteristics, standardization, and special requirements. These media mixes are listed in Table 7.

INSTRUCTIONAL REQ. / OBJECTIVE REF. NUMBER	CLASSIFICATION	R/P (VERBATIM)	R/P (PARAPHRASED)	R/F (SYMBOL/NAME)	R/F (FUNCT/LOC)	R/F (LIM/TOL/CV)	R/F (LISTS)	R/F (SEQUENCES)	U/C	U/R	DISPLAY	AUDIO-VOICE	AUDIO	TACTILE	KINESTHETIC	VISUAL: VERB/TEXT	VISUAL: PICTORIAL	VISUAL: DIAG./DRAWINGS	VISUAL: SPATIAL LAYOUT	VISUAL: MOTION	VISUAL: COLOR	RESPONSE	VERBAL/WRITTEN	POINT/TOUCH/MARK	MANIPULATE	EVALUATION	KEY SCORED	INSTRUCTOR	AUTOMATED	FEEDBACK	FREQ: IMMED/RESP	FREQ: IMMED/ERROR	FREQ: PERIODIC	FREQ: POST-SESSION	CONTENT: CORRECT ANSWER	CONTENT: R/W ELAB.	CONTENT: BRANCH	SPECIAL	TEAM INTERACTION	ENVIRONMENT	MOTION	TIME VARIABILITY	LEARNER CONTROL		COMMENT
1.1.2.4.12.3/1.1																✓							✓				✓							✓	✓	✓									
1.1.2.4.13/1																✓		✓			✓		✓					✓						✓	✓	✓									
1.1.2.4.13/1.1																✓							✓				✓							✓	✓	✓									
1.1.2.4.14/1																✓	✓	✓	✓		✓		✓					✓						✓	✓	✓									
1.1.2.4.14/1.1																✓							✓				✓							✓	✓	✓									
1.1.2.4.15/1																✓		✓			✓		✓					✓						✓	✓	✓									
1.1.2.4.15/1.1																																														
1.1.2.4.15/1.2																																														
1.1.2.4.16/1																✓		✓			✓		✓				✓							✓	✓	✓									
1.1.2.4.16/1.1																																														

Table 5-Completed Academic Media Selection Form

	1.6.1.1	1.6.1.2	1.6.1.2.2	1.6.1.3.1	1.6.1.3.2	1.6.1.3.3	1.6.1.3.4	1.6.1.4.1	1.6.1.4.2	1.6.1.4.3	1.6.1.5	1.6.2	1.6.3.1	1.6.3.2	1.6.3.3	1.6.3.4	1.6.3.5
PHYSICAL LAYOUT CHARACTERISTICS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Conformity With Shape		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Between-Panel Spatial Relations		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within-Panel Spatial Relations		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
STIMULUS PROPERTIES - INTERIOR																	
Fidelity of Visual Stimulus		✓	✓	✓	✓			✓		✓	✓	✓	✓	✓			✓
Fidelity of Aud (non voice) Stim																	
Fidelity of Kinesthetic Stimulus																	
Voice Stimulus Capability		✓	✓			✓	✓	✓	✓	✓				✓	✓	✓	
STIMULUS PROPERTIES - EXTERIOR																	
Field of View		✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	
Proportion of Distant Obj		✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	
Coloration and Shading - Obj		✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	
Visual Sensation - Motion		✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	
Shape of Objects		✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	
Resolution - Detail Given Distance		✓	✓			✓	✓	✓	✓	✓		✓	✓		✓	✓	
MANIPULATIVE PROPERTIES																	
Fidelity of Manipulation		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Timely Manip-Resp Connection		✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
RESPONSE PROPERTIES																	
Fidelity of Interior Response		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fidelity of Exterior Response		✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
INSTRUCTIONAL FEATURES																	
Instructor View of Stud. Displays		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stop Action Capability		✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Canned Demo Capability																	
Live Demo Capability						✓	✓	✓	✓	✓		✓			✓	✓	
Conditions Reset Capability		✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
EVALUATION FEATURES																	
R/W Feedback					✓												
Out of Tolerance Feedback		✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Instructor Feedback		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replay of Student Performance																	
OPPONENT																	
Maneuver Opponent		✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Non-Moving Opponent																	

Table 6-Completed Training Device Media Selection Form

Table 7--Media patterns and segments selected.

Pattern 1	
Slides/Audio and worksheet	139
Training manuals and worksheet	93
Lecture and worksheet	93
Lecture and worksheet and videotape	93
Lecture and worksheet and (model) equipment	278
Pattern 2	
Slides/Audio and worksheet	10
Slides and worksheet	142
Workbook	72
Lecture and worksheet	332
Lecture and worksheet and videotape	70
Lecture and worksheet and (model) equipment	70
Pattern 3	
CAI and part-task trainer and worksheet	208
Workbook	70
Training manuals and worksheet	348
Lecture and worksheet	70
Pattern 4	
CAI and part-task trainer and worksheet	348
Workbook	278
Lecture and worksheet and student response system and (model) equipment	70
Pattern 5	
Lecture and worksheet and student response system and (model) equipment	696
Pattern 6	
CAI and part-task trainer and worksheet	696

The six media mixes were selected on the basis of the following rationale. The first media mix was selected because it represents the most common mix of media in many Air Force training settings at the present time. Notice that this represents five different general media approaches, no one of which is a single medium. For example, the tape/slide presentations would be augmented and supported by a worksheet which might contain additional directions, test items, errata, and updates to the current version of the tape/slide program, and so on. In other medium, the worksheet might contain photographs, diagrams, and other information to support the lecture or primary medium

chosen. It is felt that this is a more realistic approach to media designation, since very few media in their "pure" form totally address a significant range of instructional situations. That is, most instruction really requires a "multimedia" approach, usually to teach one individual objective.

The second media mix represents what the contractor would characterize as a low technology media mix, with one important addition to the commonly encountered Air Force media mix outlined in media pattern one. This media mix adds one significant item, a formatted instructional workbook, to the previous media pattern. As will be seen in the results, this one addition makes considerable improvement in the number of instructional objectives which could be acceptably addressed by the resulting media mix.

The third media mix represents a higher technology approach with characteristics of easy, economical, and short turnaround time, update, and revision capabilities. It consists of a CAI system supported by some on-line part-task trainer applications, and/or hardware, and the worksheet. It also includes formatted workbooks, some use of training/reference/maintenance manuals supported by instructional worksheets, and it includes lectures supported by student handouts (worksheets).

Three major CAI systems were considered with three alternate configurations of each of the TICCIT and PLATO systems. All CAI systems are extremely capable and address the majority of instructional objectives very well (i.e., in an unconstrained setting they are usually the first or second choice for most cognitive objectives). For a variety of reasons, the CAI system recommended in these media mix explorations is the TICCIT system.

The GETS system, in its current configuration, meets most of the display requirements but the sophistication and economy of its authoring system is suspect. Since it is designed to operate primarily in a stand-alone single terminal mode, central collection of student data and other advantages of a centralized terminal network device are absent. In addition, since it is primarily a microprocessor based system, at the current state of technology, its raw computer power is also suspect.

PLATO, on the other hand, is an extremely sophisticated system with generally good display characteristics. It has the most computer power of any of the systems compared, and its authoring system is sophisticated and could be economically utilized. Its major problem, at its current state of technology, is that it is an extremely expensive system in any configuration where a relatively low number (30 or 40) of terminals are required in one site, unless the terminals are teleprocessed to a remote central processing unit. To the extent that a considerable amount of the current F-16 academic curriculum (and it is assumed of any future revisions and updates) is classified, teleprocessing to a remote site is probably not a viable alternative.

Both PLATO and GETS are evolving systems as is TICCIT, and in the event any decision is made to utilize state-of-the art media technology in subsequent revisions, updates, and modifications to the F-16 syllabus, the CAI systems should be reevaluated. The current recommendation of the contractor for the F-16 setting, is that the TICCIT system is the system of choice.

The fourth media mix eliminates use of training/reference manuals with no decrease in the number of objectives adequately addressed, and with a probable considerable increase in instructional effectiveness. The lecture format is upgraded by the addition of a student response system (the TICCIT system could be used for this also) and some actual (or models of) F-16 equipment.

The fifth media mix represents a low technology approach utilizing primarily lecture and worksheet supported by a simple student response system and models of equipment. No audiovisual technology such as slides, videotapes, or audiotapes are assumed. As will be seen, this approach fails to address the majority of instructional objectives adequately. In addition, it would provide very little variety to the unfortunate student.

The sixth media mix represents a high technology, single media exploration. The media chosen was CAI with part-task trainer capability on some terminals, supported by worksheets. This media mix addresses essentially all of the cognitive objectives in the F-16 syllabus very effectively. The richness of this media would also provide a surprising, and probably more than adequate, amount of variety to the student. For example, TICCIT's color, motion, audio, and interactive characteristics make possible a wide variety of stategies and formats, and really constitute a multimedia approach in as much as TICCIT assumes the capability of implementing videotapes on-line. The part-task trainer may be either 2-dimensional (2-D) interactive cathode ray tube (CRT) displays or computer driven, 3-dimensional (3-D) equipment attached to the terminal.

The seventh media mix consists of the primitive media selection data, which lists all of the media in the overall media pool and gives the data on each of the media as if it were the only medium allowed. This table tells how many of the 696 objectives would have been a "primary hit" (i.e., out of all the media, this medium would have been the first choice for the objective), how many were addressed by this medium as a "secondary hit" (i.e., for those objectives, this medium would have been one of the very top choices, but not the first choice), how many were addressed as acceptable by the medium as a "minor hit," (i.e., the medium could address the needs of the objective, but it is by no means a preferred medium to use), and finally, for how many objectives was that medium completely unsatisfactory in one or more of the display, response, evaluation, or feedback categories determined to be important for the objective.

3.8 Step 8: Determine Media Production and Maintenance Cost

The effort involved in this section was concentrated primarily upon determining the initial development and production and life cycle revision and update costs to the curriculum materials based on the requirements of the different media selected. Table 8 shows the cost of developing and producing a single medium module, or segment of instruction, in each media class for each of the six media mixes being considered. These figures are based on costs incurred in past materials development efforts as recorded by the contractor and include personnel, equipment, and supply, but not facility costs. This table also shows the cost of revising or updating and reproducing a single medium module or segment of instruction, for each of the media in each of the mixes. Later, this data will be combined with equipment acquisition and maintenance costs and all other relevant costs taken from the training support requirements analysis and reported in Step 12 in this document to show the total cost of the training system, given each media assignment pattern.

Table 8--Cost to develop, produce, and revise a single medium module.

Media Class	Cost to Develop/Produce	Cost to Update/Revise
CAI (TICCIT)	1,004.90	248.36
Tape/Slide	2,779.08	1,629.54
Lecture	1,751.48	751.46
Study Guide for Manual	672.50	178.28
Workbook	1,515.68	422.70

3.9 Step 9: Construct the Media Decision Models

For each mix, a media decision model was constructed. The primary factors to be considered in making each media decision were instructional effectiveness, cost, student motivation, and ready availability of standardized implementation and support equipment. As has been reported earlier, the selection team had at its disposal a complete listing of the relative instructional effectivness of every medium in the entire media pool on each instructional objective. In addition, the team had at its disposal a more focused comparison between only those media in the media mix for each media selection pattern, again based on instructional effectiveness. For Step 7 of the media selection process, the team had at its disposal the relative development, production, and revision costs of a typical module in each medium. The team drew upon its own extensive experience in

military aircrew training in determining the relative motivational characteristics of each medium, and in estimating the requirements for variety.

Finally, the initial media pool was determined to consist almost entirely of standardized equipment and approaches. It was assumed that in every case any desired equipment or materials would be readily available from, and supported by, commercial vendors from off-the-shelf stocks or from standard production runs. Weighing these characteristics against the intended emphasis of each media selection pattern (i.e., low technology pattern vs. high technology pattern, low equipment acquisition vs. low update and revision costs, etc.), the total number of instructional modules to be assigned to each medium within each pattern was determined. Table 7 shows the number of objectives, from the 696 objective total, assigned to each medium within each media selection pattern.

Figure 3 shows the general media selection model utilized within each pattern to make the individual objective media selections within the constraints of the preliminary media mix apportionment.

3.10 Step 10: Select Media for All Objectives under Each Assignment Pattern

At this point media selection proceeded for each objective under each of the six assignment patterns. The computerization of the media assignment process allowed each alternative to be computed separately. Each objective was passed through the logic of each assignment pattern and assigned an alternative medium. These patterns can then be costed, in Step 9, to determine the relative overall costs of the alternate media patterns.

3.11 Step 11: Determine the Total Cost of Each Media Assignment Pattern

Using the cost figures for each media pattern derived in Step 7, and the appropriate costs taken from the training support requirements analysis document, report no. 21 "F-16 Instructional System Cost Study Report," the overall cost for media acquisition and the ongoing costs per year for the total training system, including materials, facilities, personnel, equipment, etc., were calculated. These are reported in Table 9. This table shows, for each media pattern selected, the acquisition cost for the total training program, including instructional materials, facilities and equipment, and the ongoing costs per year for personnel, maintenance, and curriculum update and revision. (These costs apply to one training site. Subsequent sites will be less expensive since the curriculum materials will be already developed.) Also shown are the life cycle costs of each media pattern over 10 and 20 years. As can be seen, there is little signifi-

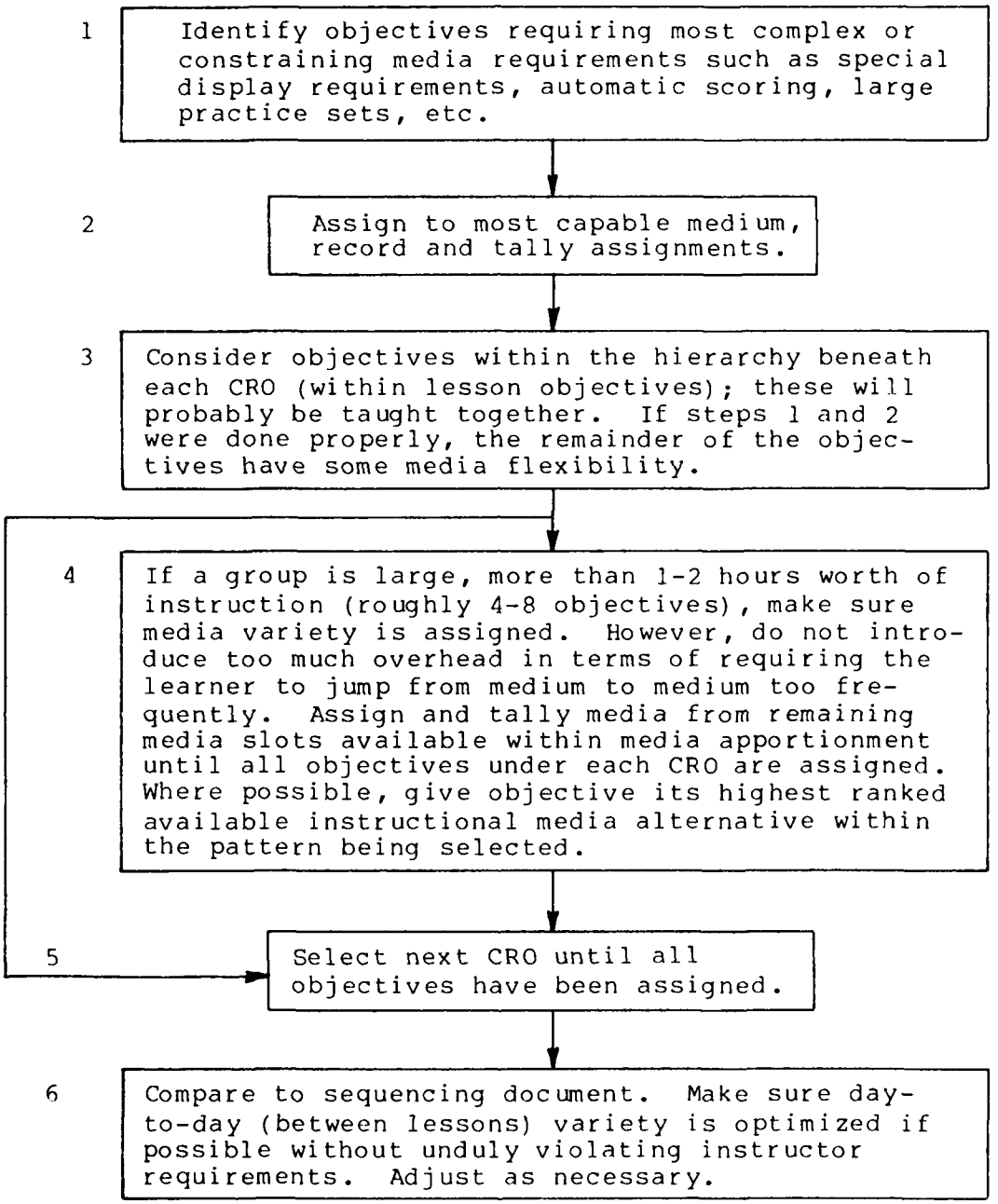


Figure 3--Media Selection Model

Table 9-Total Program Costs For Each Media Pattern

	Media Pattern 1	Media Pattern 2	Media Pattern 3	Media Pattern 4	Media Pattern 5	Media Pattern 6
Initial Acquisition Costs	20,020,200.28	19,809,798.44	21,636,352.50	21,939,563.64	20,135,229.38	21,752,953.70
Operating Costs/Year	513,958.84	566,587.57	468,864.66	474,287.24	669,772.85	451,701.97
10-Year Total Program Costs	25,159,780.00	25,475,668.00	26,324,992.00	26,682,433.00	26,832,949.00	26,269,963.00
20-Year Total Program Costs	30,299,360.00	31,141,538.00	31,013,632.00	31,425,303.00	33,530,669.00	30,786,974.00

cant difference in the cost of these training programs due to academic media selection. The costs of the aircraft operation (but not acquisition) and simulator operation and acquisition represent such a high proportion of the total training system cost that the training system costs are relatively insensitive to costs related directly to academic media.

These cost figures unavoidably reflect several systematic biases. They inadequately reflect the serious consequences of inflation on personnel costs. In addition, these costs seriously overestimate the cost of CAI and computer based part-task trainer media. For nearly 30 years, in spite of inflationary trends, the dollor cost per unit of work done by computer based devices has been dramatically and steadily coming down, unlike personnel costs. At the same time, power, flexibility, and capability are dramatically increasing. To the extent that personnel costs have been underestimated and computer costs overestimated, this may seriously distort the 10 and 20 year life cycle figures. As will be seen in the next section these may be important bias factors to bear in mind since there are serious cost trade-off factors to be considered in the F-16 training scenario.

3.12 Step 12: Review Cost Tradeoffs Related to Each Assignment Pattern

The positive and negative factors listed for each media assignment pattern in Step 6 and attached to it were examined along with the costs derived in Step 10. It was possible to conduct an informal cost tradeoff study at this time. The developer chose that media configuration for recommendation which presented the best set of positive instructional, cost, and use features. No set of guidelines was or should be set down for this because it involves a decision-making process on the part of the developer and the instructional system consumer which may involve many factors external to the system itself.

By producing the media assignments and the cost data attendant to each for several assignment patterns, the developer has laid the foundation for orderly decision-making and comparison of several ways to proceed. Further assignment patterns may be generated at this point to test new possibilities for media mixtures, and it is assumed that a negotiation between the developer/consumer and the real-world contingencies will take place at this time until the best combination of media for the funds available is determined. Moreover, when the decision is reached, both developer and consumer have an understanding of the capabilities and limitations of the resulting media system.

The media factors identified in Step 6 were compared to each other in terms of overall cost, estimated instructional effectiveness, projected motivational characteristics, and on the basis of each of the 11 critical needs of the F-16 training program identified in the analysis of the F-16 training manage-

ment system requirements and reported in the "Management System Needs and Design Concept Analysis," development report no. 12, December 1977. Given that computer based operational flight trainers (OFT) were to be available, no special or environmental concerns beyond those already imposed by the OFT were identified.

Also taken into account were the findings of the computer managed instruction study reported in "Computer Managed Instruction for the F-16 Training Program," development report no. 17, July 1978. The supporting rationale for utilizing computer managed instruction in the F-16 training program was clearly outlined in that document. The 11 critical needs outlined in the "Management System Needs and Design Concept Analysis" paper are equally germane inasmuch as they are needs of the overall F-16 training program, and not just needs related to the management of that program.

The approach taken in this section of the media selection document was to rank each of the selected media patterns on costs, instructional effectiveness, motivation, critical training program needs, and major computer managed instruction (CMI) subfunctions (scheduling, inventory, and instructional prescriptions). Multiple rankings were obtained for each of the six media selection patterns, with a brief supporting rationale for each ranking. Caution must be taken in the interpretation of these rankings inasmuch as this is a qualitative, not quantitative judgment, and for any given set of circumstances or analysis perspective, the weighting of the rankings will be far from equal. On the basis of the cost and other data, the Air Force may decide to periodically generate new media mixes and explore their capabilities as new information becomes available throughout the remainder of the project. This process is greatly simplified by virtue of the fact that the significant data base is now completely automated, along with a powerful set of computational program tools, for their manipulation in exploring new alternatives. On the basis of data now available, and the judgment of the media selection team, the following cost trade-offs pertain.

3.12.1 Cost

Cost was the first major factor to be considered. Table 9 has already reported the initial acquisition and 10- and 20- year life cycle total cost for each of the media patterns. As can be seen, based on the 20 year life cycle cost (a not unreasonable time period in the life of a modern weapon system) only a 9.6 percent difference exists between the bottom line costs of the most expensive and least expensive media pattern alternatives. When this difference is weighed against the fact that the CAI supported alternatives also offer the benefit of a potential estimated 10 percent reduction in simulator time required (conservative) and, when one considers that, as has been pointed out before, the cost figures are biased heavily against the computer supported media patterns on at least two different

important factors, this 9.6 percent difference becomes less significant. In addition, the difference between the pattern most resembling current Air Force practice and the pattern which is most heavily CAI/part-task trainer supported, is less than 2 percent in total life cycle cost, even without taking into account the anticomputer bias of the cost figures. For a direct cost comparison, the numbers will be allowed to speak for themselves, and these other factors will be taken into account in later rankings.

The media selection patterns were given the following cost rankings by the media selection team:

Patterns 2 and 6 were ranked 1 (best or lowest cost).
Patterns 1, 3, and 4 were ranked 2.
Pattern 5 was ranked 3.

3.12.2 Instructional Effectiveness

On the second major factor, instructional effectiveness, the media selection team utilized the primitive media selection data which showed the extent to which each media mix dealt with the 696 instructional objectives effectively; i.e., the extent with which one or more media in that media pattern was a first or second choice in which to teach that objective on the basis of instructional capabilities of the entire, unconstrained media pool. In this comparison, as can be seen from the tables, there were wide differences revealed in the estimated instructional effectiveness of these six media patterns. The media selection team assigned the following rankings:

Patterns 3, 4, and 6 were given rankings of 1.
Pattern 1 was given a ranking of 2.
Pattern 2 was given a ranking of 5.
Pattern 5 was given a ranking of 6.

3.12.3 Motivation

The media patterns were then compared in terms of their motivational characteristics. Characteristics which greatly enhance the motivational reaction of students to the instruction by virtue of the medium include, but are not limited to, the interactive capability of the media (i.e., the degree to which it engages the student's attention, encourages his interaction, and allows his control); display salience (i.e., such things as color, sound, graphics, blinking, motion, etc.); and display latitude (i.e., the extent to which a medium can assume very different display characteristics, ranging from all text to heavily graphic types of presentations, etc.) This area is highly subjective, and considerable disagreements between raters can easily be generated.

A main active principle seems to be the extent to which the medium can provide the student with a rich and varied menu of

displays, interactions, and so on in the instructional setting with the media pattern to be analyzed. On the basis of these concerns, the media selection team ranked the media on motivational characteristics as follows:

Pattern 4 was given a 1 ranking.
Pattern 3 was given a 2 ranking.
Pattern 6 was given a 3 ranking.
Pattern 1 was given a 4 ranking.
Pattern 2 was given a 5 ranking.
Pattern 5 was given a 6 ranking.

Note that it was considered by the team that those cases where a rich, interactive medium, such as CAI, was mixed with lecture, were by far the most motivational media patterns. Also note that the all-CAI pattern was considered to be more motivational due to its rich display characteristics and its flexibility (including "gaming" capabilities) than an all-lecture format such as pattern 5. This data seems to be upheld by data on such settings as the Navy's S-3A aircrew setting where Naval flight officers report very good attitudes towards extensive blocks of all CAI instruction (even after 4-6 hour time periods).

3.12.4 Maintainability

The next factor to be considered was the first of the 11 critical needs identified for the F-16 training program, namely, the need for lifetime maintenance of the training program. Several factors affect the "maintainability" of a training program. One factor is the cost, the ease, the flexibility, and the personnel required to revise and update the course in the media mix selected. Another factor is the ease with which critical data, providing the basis for the change, can be collected, analyzed, and utilized. Yet another contributor to this factor lies in the extent to which a medium can or cannot discipline, structure, or support the quality control of those revisions and updates while providing an historical audit trail to the various generations of updates which have been created. Other factors include such concerns as the fact that a highly varied media mix requires many different technologies and a wide variety of personnel skills and talents to maintain revision and update efforts.

Another factor to be considered was the fact that in those cases where a media pattern depends heavily upon materials external to the training program (i.e., materials developed for other purposes, such as gun camera, videotapes, maintenance materials and references, and other technical manuals), the training program has inadequate control and information to successfully revise and update the program completely. Changes in these external materials are often consolidated and controlled by other people not familiar with the training implications of changes which they make.

One last consideration: Historically, all-lecture courses have been among the most difficult to maintain and update in military programs. The uniformity, consistency, and quality control of the instructional approach and method of use most rapidly deteriorates in those cases where an all-lecture or heavy-lecture orientation is taken. Control in such cases is for the most part surrendered by the training program itself and of necessity, assumed by the individual instructors who may vary widely in motivation, orientation, skill, and knowledge, or for any given instructor, based on health, interest, and a variety of external concerns. Even though lecture is an easily maintainable medium physically, it is almost impossible to maintain integrity. On the basis of these and other considerations, the media selection team assigned the following rankings on this factor:

Media pattern 6 was assigned a 1 ranking.
Media pattern 4 was assigned a 2 ranking.
Media pattern 1 was assigned a 3 ranking.
Media pattern 3 was assigned a 4 ranking.
Media pattern 2 was assigned a 5 ranking.
Media pattern 5 was assigned a 6 ranking.

3.12.5 Standardization

The next major factor to be considered was the need to standardize the approach to modifying the training system. This factor deals with the degree to which a media pattern implicitly or explicitly offers information or control which would tend to standardize the approach to modifying the instructional system including curriculum, organization, sequence, etc. In the military setting, with its frequent personnel turnover, this can be a real problem. The CAI related media mixes, with their interactive authoring systems, data requirements, and syntax structures would have an advantage here. They would likewise have an advantage due to the fact that they offer the potential for better record keeping, data analysis, and computational support in subsequent decision making concerning modifications to the training system. In addition, the more complex the media mix, that is, the more media which are involved, the more standards which would have to be evolved. On the basis of these and other concerns, the media selection team assigned the following rankings:

Media pattern 6 was assigned a 1 ranking.
Media pattern 4 was assigned a 2 ranking.
Media pattern 3 was assigned a 3 ranking.
Media pattern 5 was assigned a 4 ranking.
Media pattern 2 was assigned a 5 ranking.
Media pattern 1 was assigned a 6 ranking.

3.12.6 Information Availability

The next major factor considered was the need to explore the effects of varying program parameters. This deals with the

extent to which use of a particular media pattern readily provides information for analytical support to program management for support decision making. Obviously the computer assisted instruction supported systems would be advantageous on this factor as well as any media pattern which included student responding systems (assumed to have data collection capabilities). The media selection team assigned the following rankings on this factor:

Media pattern 6 was ranked 1.
Media pattern 4 was ranked 2.
Media pattern 3 was ranked 3.
Media pattern 5 was ranked 4.
Media pattern 2 was ranked 5.
Media pattern 1 was ranked 6.

3.12.7 Response to Change Requirements

The next factor to be examined was the need for the media pattern to support quick response. The need for quick response overlaps with some of the concerns of rapid and simple revision and update. It also includes the ability to restructure, or modify, important characteristics of the training program, such as developing alternative sequences, extracting and/or restructuring subsets of the curriculum to meet changing student population requirements, etc. The extent to which the curriculum can be modularized, reidentified, and recombined supports high rankings on this factor.

Stand-alone media packages which could be recombined, and of course computer assisted instruction modules have the advantage on this factor. Choice of lecture instruction usually assumes that a group of students large enough to make an instructor's time worthwhile will be assembled for a block of instruction with the attendant implication that several objectives worthy of instruction will be covered, and therefore must be documented in the lecture guide. Lectures, therefore, suffer a disadvantage on this factor, in spite of the fact that it could be said that the instructor is the most flexible of the media, being able to think and modify instruction on his feet. However, the idiosyncratic, nonstandardized, uncontrolled nature of this capability is seen as a serious weakness. Again, to the extent that a media pattern depends upon external support material, such as training and reference manuals, videotapes or other audiovisual materials developed outside the training program, that media pattern suffers a severe disadvantage. The media selection team assigned the following rankings on this factor:

Media pattern 6 was ranked 1.
Media pattern 4 was ranked 2.
Media pattern 2 was ranked 3.
Media pattern 3 was ranked 4.
Media pattern 5 was ranked 5.
Media pattern 1 was ranked 6.

3.12.8 Problem Detection

The next critical factor involves the need for early detection of problems within the training program. The extent to which the training program can gather student performance data and relate it to specific instructional modules is extremely important. Sensitivity to potential and existing problems is necessary to provide optimum management in all phases of training. Early problem identification is important in two ways. It makes the problem easier to solve, and it minimizes the chance for program disruption. Obviously, tightly controlled test and student data situations, such as CAI and student response systems, offer significant support in meeting this need.

There is some question as to whether the instructor or the computer function more effectively in detecting problems in the system. While the intuitions of an experienced instructor are powerful and often defy all logic in their insight, at least two problems exist in dependence on this means of problem identification. One is the limited scope of the instructor in terms of relating isolated pieces of data to the overall program. That is, an instructor, immersed in the numerous problems of day-to-day student performance analysis for many students on many objectives, may have trouble detecting subtle, but extremely important patterns of performance deficiency.

The second problem lies in the fact that individual instructors will vary widely in terms of their intuition and insight, and in terms of the accuracy of their conclusions regarding the nature, locus, and causes of problems. Again, the extent to which a media pattern depends on external material outside its control for instructional purposes causes problems on this variable. The media selection team assigned the following rankings on this variable:

Media pattern 6 has a 1 ranking.
Media pattern 5 has a 2 ranking.
Media pattern 4 has a 3 ranking.
Media pattern 3 has a 4 ranking.
Media pattern 2 has a 5 ranking.
Media pattern 1 has a 6 ranking.

3.12.9 Response to New Demand Levels

The next factor involves the need for flexibility to meet changing demands on the program. This factor deals with the ability of the training program, within the media pattern, to be changed quickly to meet changing requirements such as changing student population characteristics. Also important for this factor are such concerns as the simple ability of the program within the pattern to rapidly replicate itself to handle many more students in a very short time. Of course, training programs heavily dependent upon actual instructors will be seriously disadvantaged by this type of program. When there is a critical

need for many highly trained pilots, difficulty of obtaining qualified pilots to increase the ranks of the instructor corps and the time available to adequately train them for the task will be severely limited, which argues against this media pattern.

Again, flexibility deals with such other concerns as the ability to expand and take over as many flight and simulator related activities as possible in the event training flights and fuel must be seriously constrained. Stand-alone mediated instructional packages not requiring instructors would have an advantageous position on this factor, since additional media equipment can generally be obtained in a very short time and additional copies of media packages can generally be quickly obtained in an emergency. On the basis of these and other concerns, the media selection team assigned the following rankings on this factor:

Media pattern 6 was given a 1 ranking.
Media pattern 4 was given a 2 ranking.
Media pattern 3 was given a 3 ranking.
Media Pattern 2 was given a 4 ranking.
Media Pattern 1 was given a 5 ranking.
Media pattern 5 was given a 6 ranking.

3.12.10 Self-monitoring

The next factor is the need for a self-monitoring system. An earlier factor dealt with the ability of the system to monitor student performance and to identify early problems. This factor deals more with the ability of the media pattern to provide information concerning its own success. That is, does the media pattern provide data collection analysis capability that would make it easier to determine how well the system is working in terms of meeting its own stated performance goals? Is there an ability to screen data going in and out of the training program to detect unreasonable values? How is the training program doing compared to real world operating goals, etc.? It is felt that the real time data collection and analysis capabilities of the CAI and student responding systems have an advantage on this front; however, the intuitions and insights of an experienced instructor are not to be discounted. Clearly, in this case, the patterns suffering the most disadvantage are those which have heavy emphasis on stand-alone mediated instructional packages such as tape/slides, workbooks, reference manuals, etc. On the basis of these, and other concerns, the media selection team made the following rankings for this factor:

Media pattern 6 was ranked 1.
Media pattern 4 was ranked 2.
Media pattern 5 was ranked 3.
Media pattern 3 was ranked 4.
Media pattern 2 was ranked 5.
Media pattern 1 was ranked 6.

3.12.11 Data Management

The next identified critical needs are the needs to effectively deal with large amounts of data and the need to establish a historical data base. These needs can actually be considered to be different aspects of one important factor which has been adequately dealt with as several parts of the other factors previously ranked, such as, need for a self-monitoring system, need for quick response, need to explore the effect of varying program parameters, etc. Therefore, no further ranking was given on these factors by the media selection team.

3.12.12 Redundancy

The next factor, need for redundancy, is considered to be an extremely important factor. Redundancy prevents losing important data through unforeseen circumstances and deals with such factors as the ability of the system data collection mechanism to detect and protect against human and other errors. Loss of critical data in an ongoing program greatly reduces effectiveness, prevents reliable decision making, and weakens future planning efforts. Redundancy deals with such concerns as the ability of the system to recover from equipment downtime, and the degree to which backups are available (such as extra tape/slide projectors, etc.).

On this factor, it was determined that lecture-based media patterns enjoyed an advantage. Generally, in nonemergency situations and especially within TAC, there will be extra academic instructors available from the ranks of the flight instructors and from other places. Modern computer assisted instruction systems, with their extreme reliability, and in the case of TICCIT, at least, the ability to gradually degrade (i.e., pieces of the system can break down without bringing down the system), also are strong on this factor. The weakest patterns on this factor would be those which depend on hard to get, nonstandardized, unreliable equipment in short supply. Since care was taken to eliminate such media devices from the master media pool to start with, it was felt by the media selection team that there was not much difference between the media patterns on this factor. Their ranking on this factor is:

Media pattern 5 was given a 1 ranking.
All other media patterns were given a 2 ranking.

3.12.13 Operability By Users

The next factor to be considered was the need for the system to be operable at the user's level. That is, it is important that the training media employed be sufficiently "human engineered" and responsive in its operation that users with little or no training can make effective use of the media and materials with little or no instruction. Highly familiar media, such as formatted workbooks, would clearly be strong on this factor. Lecture based patterns would similarly be strong.

The computer assisted instruction patterns had the potential to be even stronger on this factor inasmuch as it has been demonstrated that elementary school children can make very effective use of computer assisted instruction systems if care is taken in the proper construction of the lesson materials, the terminal training materials, and the diagnostic messages given to the student and the instructor. Probably the weakest on this pattern, are some of the so-called "standard" media devices such as slide projectors, tape recorders, videotape machines, and student responding systems. On the basis of these, and other considerations, the media selection team assigned the following rankings on this factor:

Media pattern 5 was given a 1 ranking.
Media pattern 6 was given a 2 ranking.
Media pattern 4 was given a 3 ranking.
Media pattern 3 was given a 4 ranking.
Media pattern 1 was given a 5 ranking.
Media pattern 2 was given a 6 ranking.

3.12.14 Scheduling and Inventory

The CMI concerns outlined in development report no. 17, July 1978, center primarily around the need for a testing component, student records component, scheduling component, inventory component, and prescriptive component. Testing and student records have been dealt with extensively in factors previously considered. Scheduling and inventory requirements and capability will vary widely between training media patterns. Factors which affect a media pattern's ranking in this area include such considerations as the amount of complex scheduling required by the training program administrators in recovering from a missed session (e.g., missing a lecture means perhaps as many as 20 people need to be rescheduled around their other time demands such as flying, simulators, etc.) and around such concerns as making maximum use of perhaps limited materials or equipment (such as tape/slide projectors, etc.). On the other hand, an inventory component deals with the capability of a media pattern to provide information on the stocks on hand of various consumables, the location of and responsibility for equipment and materials, and the maintenance status of critical equipment, etc.

As can be seen, a lecture-only media pattern requires little inventory support but causes problems of scheduling with little support for solutions in the event a lecture for some reason cannot be held at its originally identified time. Those patterns which will be the weakest on this factor are those which require a lot of consumable material or individual pieces of audiovisual equipment, and/or those which have limited scheduling flexibility. On the basis of these and other considerations, the media selection team have assigned the following rankings on this factor:

Media pattern 6 was given a 1 ranking.
Media pattern 5 was given a 2 ranking.
Media pattern 4 was given a 3 ranking.
Media pattern 3 was given a 4 ranking.
Media pattern 1 was given a 5 ranking.
Media pattern 2 was given a 6 ranking.

3.12.15 Diagnostics and Prescription

The final factor to be considered in the media selection team pattern rankings is that of the ability within the media mix to diagnose student errors and provide individual prescriptions to help the student correct his problems. To the extent that class sizes can be kept small and consistent, and to the extent that student contact with individual instructors can be maximized so the instructor learns to recognize individual student problems through extensive interaction with the same students, lecture-based instruction might be fair on this factor.

Certainly, computer assisted instruction, with its ability to analyze student responses and recognize many alternatives, to correct incorrect responses, to detect time taken to respond, to record every student response and analyze student performance on the basis of an entire performance history instead of one or two recent answers, would be very strong on this factor. To the extent that testing done on student responding systems were cleverly and carefully designed, and to the extent that data analysis capabilities were provided with the student responding systems, they would be reasonably strong on this factor. Probably the weakest patterns on this factor are those where the student must analyze his own answers and determine whether he was correct or incorrect. On the basis of these and other considerations, the media selection team assigned the following rankings on this factor:

Media pattern 6 was given a 1 ranking.
Media pattern 5 was given a 2 ranking.
Media pattern 4 was given a 3 ranking.
Media pattern 3 was given a 4 ranking.
Media pattern 2 was given a 5 ranking.
Media pattern 1 was given a 6 ranking.

For purposes of some rough comparisons, and in recognition of the fact that the average reader will be unable to resist the temptation to do so, the media selection team has provided a summation of these rankings for each media pattern. Note that in any given situation, any one of these 14 factors may totally override all others in weight. Therefore, bear in mind that this summary is a weak generalization at best, and is not to be applied blindly, as if it were a real, quantitative measure of some sort. It is a guide to thinking, and an indication only. The individual rankings and the sum are summarized in Table 10. As will be seen later, the analysis which has gone into the determination of these rankings has provided a clear set of

TABLE 10 - MEDIA PATTERN COST TRADE-OFF RANKINGS

EVALUATION FACTORS	MEDIA PATTERNS					
	ONE	TWO	THREE	FOUR	FIVE	SIX
1. Cost	2	1	2	2	3	1
2. Instructional effectiveness	2	5	1	1	6	1
3. Motivational characteristics	4	5	2	1	6	3
4. Need for lifetime maintenance of the training program	3	5	4*	2	6	1
5. Need to standardize the approach to modifying the training system	6	5	3	2	4	1
6. Need to explore the effect of varying program parameters	5	5	3	2	4	1
7. Need for quick response	6	3	4*	2	5	1
8. Need for early detection of problems	6	5	4*	3	2	1
9. Need for flexibility to meet changing demands on the program	5	4	3	2	6	1
10. Need for self-monitoring system	6	5	4	2	3	1
11. Need for redundancy	2	2	2	2	1	2
12. Need for the system to be operable at the user level	5	6	4	3	1	2
13. Inventory and scheduling capabilities and requirements	5	6	4	3	2	1
14. Instruction prescription capacity	6	5	4	3	2	1
TOTAL MERIT SCORE	**63**	**47**	**49**	**30**	**51**	**18**

*Assumption is that manual revisions will be converted to CAI.

recommendations concerning the media pattern which the Air Force should embrace as the training program matures. Bear in mind, in interpreting the table and the rankings, that a low ranking means an advantageous media pattern.

3.13 Step 13: Develop Near Term and Far Term Selections

At this point in the selection process, the project team deviated from the original media selection plan. Because the initial objectives for the B/C course had been developed with inadequate OTD team input, the media selection team determined that a media mix recommendation would be inappropriate without first conducting additional analyses. Consequently, the OTD team reviewed and revised the list of ojectives and published an updated inventory of objectives in the form of a segment list. These objectives were then reentered into the media selection process at Step 6: Determine Instructional Media Requirements of Each Objective. Because of the similarity between the second objectives list and the first, this change had little impact on Steps 1-5. Because the later stages of media selection deal primarily with mixes of media rather than objectives, this change had little impact on Steps 7-12. Still, it represented an extra investment of resources that may be avoided by future development teams, and an unnecessary recycling through the media selection process.

The media selection team now had at its disposal the following information: A prioritized list of media mix alternatives (Table 10), a prioritized list of academic media for each academic objective, and a prioritized list of simulation media for each hands-on objective. Their task was to examine the media selections for each objective, objective by objective, determining first, second, and third choice media for the near term 1980 syllabus and for the far term 1990's syllabus. The purpose of selecting second and third options was to allow for flexibility in later choices. A syllabus consisting of all first choice media could be extremely unbalanced in its response to the 14 evaluation factors listed in Table 10. Such a syllabus could be prohibitively expensive, bore students by chaining them to a single medium all day, or distract them by constantly switching them from one medium to another. There is no one perfect medium for all objectives. Tradeoffs among the evaluation criteria must be negotiated in order to develop a syllabus that balances the evaluation criteria against one another as well as against the identified constraints of the instructional system.

The media selection team developed two media mixes. The first mix was the unconstrained, far term ideal syllabus. The second mix was the real world, near term 1980 syllabus. These mixes were as follows:

Table 11--Far Term Syllabus Academic Media Selections

	Medium	No. Of Objectives
1.	Tutorial + lesson guide	160
2.	CAI + lesson guide	109
3.	Tutorial + visual motion	41
4.	CAI + videotape	34
5.	Tutorial + model/actual equipment	27
6.	CAI + videotape + part-task trainer	5
7.	Workbook + slides	1
8.	Lecture + lesson guide	1
9.	No acceptable medium	1
	TOTAL	379

Table 12--Near Term Syllabus Academic Media Selections

	Medium	No. Of Objectives
1.	Lecture + lesson guide	108
2.	Workbook + lesson guide	98
3.	Lecture + visual motion	66
4.	Seminar + lesson guide	43
5.	Lecture + model/actual equipment	19
6.	Workbook + slides	14
7.	Lecture + student response system	13
8.	Seminar + visual motion	8
9.	Seminar + model/actual equipment	6
10.	Lecture + audio	5

Table 12 (Continued)

Medium	No. Of Objectives
11. Seminar + audio	2
12. Workbook + audio	1
13. Tutorial + model/actual equipment	1
14. CFT + tape/slides	1
TOTAL	385

Notice that the number of objectives for these two syllabi differ by six. Each time the objective list was reviewed, objectives were altered through addition, deletion, and modification. As each successive iteration used newer and more accurate data, the old data were stored in the historical data base.

While the OTD team was satisfied with the far term syllabus, the near term syllabus media selections did not seem consistent with the manpower constraints of the F-16 training program. McDill AFB is programmed to have a 12 man staff of instructors, but since the squadron commander and operations officer will probably not teach, their instructor staff is actually only 10. Ten men is a small staff for a media mix so heavily dependent on instructor intensive media such as seminars, tutorials, and lectures. Therefore, the OTD team reviewed their initial media selections for academic objectives and produced an alternative near term syllabus that was less instructor intensive.

Table 13--Revised Near Term Syllabus Academic Media Selections

	Medium	No. Of Objectives
1.	Seminar + lesson guide	157
2.	Seminar + visual motion	68
3.	Workbook + slides	61
4.	Workbook + lesson guide	60
5.	Seminar + model/actual equipment	23
6.	No media assigned (oversight)	7
7.	Tutorial + model/actual equipment	5
8.	Tape/slide + lesson guide	3
9.	Workbook + audio	3
10.	Seminar + audio	2
11.	Lecture + model/actual equipment	2
12.	Lecture + student response system	2
13.	Videotape + lesson guide	1
14.	Tutorial + lesson guide	1
15.	Tutorial + visual motion	1
16.	No acceptable media	1
	TOTAL	397

The hands-on or simulation media selection process did not require a rewrite of the initial list of objectives. Again, two syllabi were developed, one for near term and one for far term. The initial selections were as follows.

Table 14--Near Term Syllabus Training Device Selections

	No. Instructional Events
F-16 or F-16B aircraft	183
CFT	101
ASPT	100
DSS	80
Actual equipment	23
SMS trainer	22
Avionics display	21
F-16B	9
EPT	6
Cockpit mockup	3
Panel mockup	1
F-16A	0
WST	0
SAAC	0
RWR	0
Stick and throttle trainer	0
TOTAL	549

Table 15--Far Term Syllabus Training Device Media Selections

	No. Instructional Events
OFT	265
F-16A or F-16B aircraft	298
CFT	80
OFT and NVS	67
F-16B	12
SMS trainer	9
Actual equipment	7
EPT	6
OFT and DRLMS	6
ASPT	0
DSS	0
TOTAL	650

Notice that the number of instructional events is greater for the far term syllabus. This represents a desire on the part of the OTD team for greater instructional flexibility in the syllabus of the future. There are currently just over 500 hands-on objectives. Some of these objectives are not satisfied by a single instructional event. In a single training device, however, some require a two or three device progression, such as CFT, OFT, F-16B. This requires events and trainers for a single objective. This system is explained in greater detail in development report no. 23, "F-16 Instructional Sequencing Plan Report."

3.14 Step 14: Prepare Segment List

This step represents a stage of the syllabus development process, but also has considerable impact on media selection. The instructional objectives were organized into segments or lessons of 10-20 minutes each, consisting of 3-5 objectives. If these objectives were in different media, the development team had to select the single medium most appropriate to that segment. In most cases, the instructional segment had a single or at least a dominant medium, so the decision was straightforward.

3.15 Step 15: Update Media Selection

Subsequent development steps, such as segment listing, lesson planning, lesson modification, and syllabus update all impact the media selected for use in the F-16 training program. Because the original prioritized list of media selected for each objective is still available in the project data base, second, third, and fourth choice media are readily available. Where new objectives are developed, the development team can go directly to step 6, and determine instructional media requirements for each objective. This involves completing an objectives analysis worksheet (Tables 1 and 2) for each new objective and comparing it directly to a media selection matrix (Tables 3 and 4). This will produce a ranked list of media alternatives, which may be selected from on the basis of ongoing system constraints, as identified in Section 2.4.

4.0 LIST OF AUDIO VISUAL PROGRAMS

This list is the original version (8 Aug 1979) of the segments to be produced. Revisions are made to this list affecting the media selection, wording of the objectives, and length of the programs. These revisions are made in a systematic process of both contractor and OTD team review and approval. An updated list of segments is available at any time TAC may request one.

The following is a list of tape/slides and workbook slide type programs only. For a complete segment list including all media types see development report no. 24, "F-16 Coursewares and Syllabi Delivery Schedule."

Type of Program	Title	Est. Time/ Hours
Tape Slide		
TS101	Exterior Aircraft Inspection Checklist Procedures	.5
TS102	Normal and External Power Engine Start Procedures	.5
TS103	Procedures for Single-Ship Line-Up, Takeoff, Climb, and Departure	.3
TS104	HOM mode: Uses, Procedures, and Symbology	.3
TS105	EDR and RNG Modes; Uses, Procedures, and Symbology, Including Cruise Energy Management Considerations	.4
TS106	Introduction to Navigation Aids	.3
TS107	Procedures for Formation Taxi and Formation Lineup Checklist	.3
TS108	Lost Wingman and Chase Procedures	.4
TS110	Auto Pilot System	.5
TS111	Malfunction Identification: Dual FCS Failures	.5
TS112	Malfunction Identification: Flight Control Failures	.5
TS113	Malfunction Identification: Engine Fire/ Overheat	.5

Type of Program	Title	Est. Time/ Hours
TS114	Malfunction Identification: Engine	.4
TS115	Malfunction Identification: Fuel System	.3
TS116	Malfunction Identification: Electrical Power Supply	.4
TS117	Malfunction Identification: Hydraulic System	.4
TS201	Missile Attack in AAM Mode with AIM-9J	.3
TS202	Missile Attack in AAM Mode with AIM-9L	.3
TS203	Switchology and HUD Symbology for Back Up Modes	.5
TS204	Switchology and Symbology for AIM-9 Employment Using Manual Reticle	.5
TS204	Procedures for Air-to-Air Radar Search and Lock-on	.5
TS206	Day/Night Interceptor Signals	.3
TS301	Malfunction, Contingencies, and Abnormal Procedures During Air-to-Air Refueling	.4
TS302	HUD Energy Management Symbology	.5
TS601	External Stores Inspections Including Wing and Center Pylons, BRU 31/A, and SUU 20 B/A	.4
TS602	Procedures for Verifying Position Using INS Data and Performing All INS Updates Including Radar Altitude Calibration	.5
TS603	Airborne Radar Approach Procedures	.4
TS801	Chaff/Flare Preflight and Setup	.5
Workbook Slide		
WS101	Cockpit Ingress, Interior and Prestart Checklists	.5
WS102	Considerations and Application of Flight Control System Self-test	.3

Type of Program	Title	Est. Time/ Hours
WS103	Before Taxi Checklist Procedures	.3
WS104	Taxi and Before Takeoff Checklists, Including Single-Ship Taxi and Maintenance Arming Procedures	.5
WS105	Takeoff Emergency Procedures Including Abort, Arrestment, and Low Altitude Ejection	.5
WS106	Procedures for Night Ground Operations	.3
WS107	Night Visual Distress Signals	.3
WS108	Procedures for Formation Departure	.4
WS109	Procedures for Flying Formation	.5
WS110	Two-Ship Tactical Formation Positions	.5
WS111	Procedures for Two-Ship Delayed 90° and 45° Tactical Turns	.5
WS112	Procedures for Formation Recovery	.5
WS113	Four-Ship Tactical Formation Overview	.5
WS114	Procedures for Four-Ship Delayed 90° and 45° Turns	.5
WS115	Local Area Terminal Procedures Including VFR Reentry	.5
WS116	Penetration and Enroute Descent Procedures	.5
WS117	TACAN Holding, Penetration, and Approach; Circling Approach; and Missed Approach	.5
WS118	Procedures for ILS and Localizer Only Approaches	.5
WS119	Procedures for PAR, ASR, and Low Altitude Box Pattern	.5
WS120	Varieties of Approaches (Visual and Instrument) and Applications of Each	.5
WS121	Procedure for INS Alignment, Including Present Position and Destination Coordinates	.5
WS122	Procedures for Stored Heading and Best Available True Heading (BATH) Alignment	.3

Type of Program	Title	Est. Time/ Hours
WS123	SMS Procedures for Stores Loading and Verification	.5
WS124	Penetration AIDS System	1.0
WS201	Switchology and Symbology for AIM-9L in Missile Override/Dogfight Mode	.4
WS202	Special Considerations for Missile Attack in Override/Dogfight Mode	.4
WS203	Procedures for Formation Takeoff Including Flight Lead Considerations	.4
WS204	Procedures and Special Considerations for IMC/Night Intercept and ID	1.0
WS301	SMS Setup, Verification, and Loading: An Overview	.5
WS302	AAR Procedures: Observation Position, Formations, Refueling Sequences, Aircraft Systems Checks	.5
WS303	AAR Procedures: Precontact, Contact, Maintaining Position, Disconnect, and Radio Calls	.5
WS304	Computed Gun Attack Modes: LCOS and SS	.5
WS305	Procedures for Formation Recovery and Landing (Lead and Wing)	.4

REFERENCES

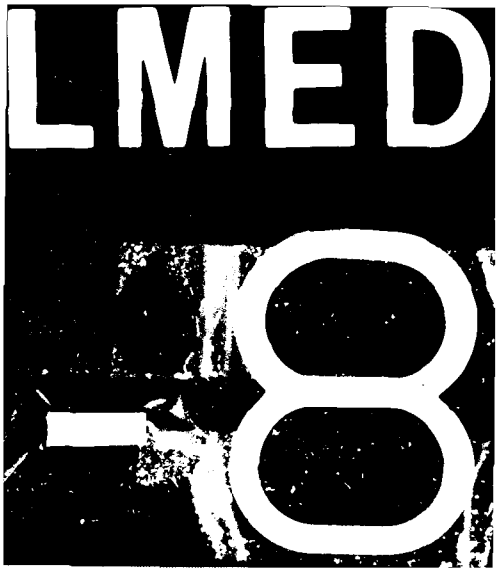
Braby, Richard: Henry, James M.; Parrish, William F.; & Swope, William M. A Technique for Choosing Cost-Effective Instructional Delivery Systems. Training Analysis and Evaluation Group Report No. 16, April 1975, Research and Program Development, Naval Education and Training.

Hughes, John A.; Campbell, J. Olin; & Hymes, Jonah P. F-18 Instructional Design--Media Trade-off Study. Document prepared by Courseware, Inc. for McDonnell Douglas Corp, St. Louis, Miss., in partial fulfillment of Contract A6820-000-092, August 1977.

Sugarman, R.; Johnson, S.; & Ring, W. B-1 Systems Approach to Training Final Report. Calspan Corporation, Buffalo, New York, 1975.

Travero, R.M.W. Man's Information System, Chandler Publishing Company, Siranton, 1970.

Walker, R.A. Post-hoc Evaluation S-3A Instruction Systems Development Plan. Final report, February 1978, Courseware, Research Projects Agency.


LMED
-8